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THE AMERICAN REVIEW OF TUBERCULOSIS

JOURNAL OF

THE NATIONAL ASSOCIATION FOR THE STUDY AND PREVENTION OF TUBERCULOSIS

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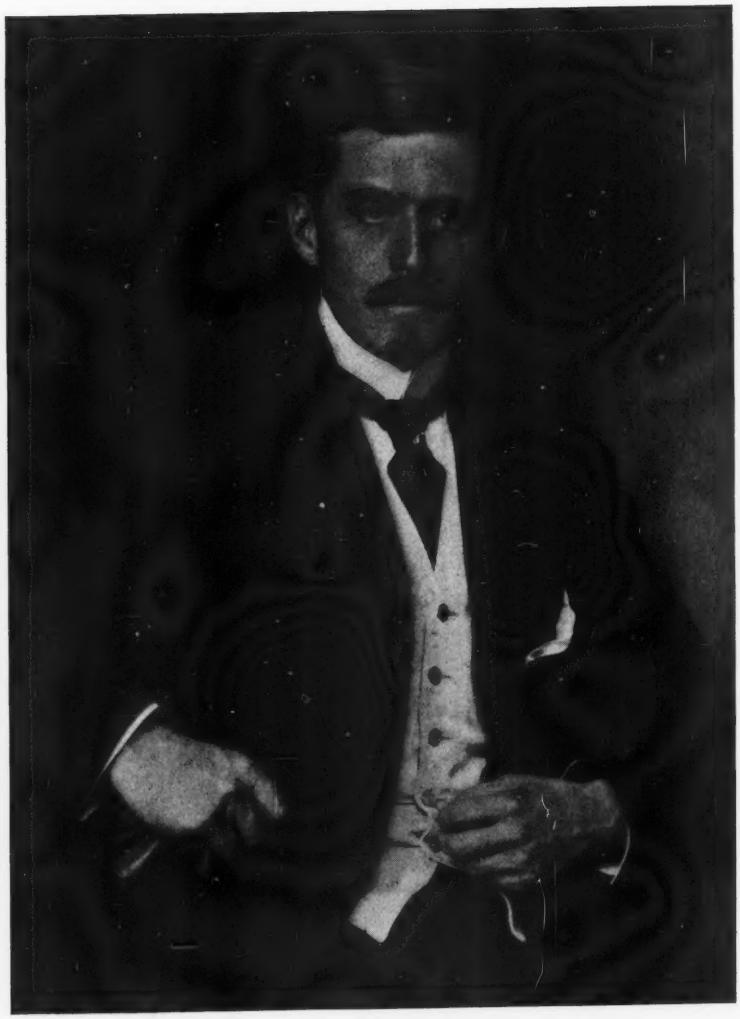

Herbert Maxon King
1864-1917

Herbert Maxon King

1864-1917

The ranks of the tuberculosis workers have been sadly depleted since the beginning of the great war—Roemer and Cornet in Germany, Landouzy in France, Trudeau and now King in America. In the present ferment and turmoil of war, in the face of deaths by thousands, the loss of a few workers, it might seem, could be passed over in silence. To those, however, who have been engaged in the struggle against tuberculosis, the loss of leaders is ever deeply felt.

Born at Adams, N. Y., August 11, 1864, Herbert Maxon King studied first at Dartmouth College and later (1887) obtained his degree in medicine from the New York University Medical College. After studying in Paris and serving for a time in the Marine Hospital Service, he began practice in Grand Rapids and specialized in nose and throat work until 1902 when he was called to take charge of the Loomis Sanatorium.

Here his real life work began. He took charge of an institution that had been, to say the least, not well managed, and so reorganized and developed it that today it stands preëminent among the private sanatoriums for tuberculosis in the east. His task was not easy for he dealt largely with patients financially able to do as they chose, but his personal interest in them, his charm of manner and well recognized ability kept many for years in the sanatorium in order to remain in close touch with such a man.

In the department devoted to poorer patients, need arose for increased accommodations, which led King to study and devise the first shack to be used in the treatment of tuberculosis. The erection of this shack revolutionized in America the ideas of construction of sanatorium quarters. A little later he built a model infirmary for patients needing absolute or partial rest. Combined with this strict rest in bed when necessary, he followed for years the method of auto-inoculation, having his patients at first do forestry but later build roads. He published from time to time the results of his experience with this form of treatment and as an adjunct to it papers on the opsonic index. The food

problem was diligently studied and dietitians put in charge of the table. His papers are valuable additions to the knowledge of this subject. An extensive study of the post-discharge history of the patients from the Loomis Sanatorium was made for he, like other sanatorium workers, had asked the question how worth while it was. His answer was a decided affirmative. This work led to the consideration of prognosis and it is interesting to note that his first and last papers dealt with this subject. While still in Michigan he was impressed with the resistance to tuberculosis of children with parental tuberculosis. He attributed this resistance at that time to the effects of heredity clearly recognizing the results due probably, in the light of our present knowledge, to repeated small infections.

He was deeply interested in scientific work as the fine Babbit Memorial Laboratory of the Loomis Sanatorium bears testimony. His enthusiasm led to its erection.

A look at the man revealed his artistic temperament; his very dress betrayed it. His hobby was the study of church architecture and his knowledge of it profound. His greatest pleasure was a tour of the cathedrals of England and France and he felt bitterly the destruction of Rheims, for this (June, 1914) was the last foreign cathedral he ever visited.

Strong of purpose, intolerant of pettiness of action or deed, conscious of the faith that was in him, King has gone from us. Above his knowledge of tuberculosis, above his scientific attainments there remain to his friends the picture of a wonderful and charming personality and the memory of a true friend.

L. B.

CHRONOLOGICAL LIST OF PAPERS READ BEFORE MEDICAL SOCIETIES OR CONTRIBUTED TO THE MEDICAL PRESS BY DOCTOR HERBERT MAXON KING

A Contribution to the Study of the Etiology of Tuberculosis. Read at meeting of the Grand Rapids Academy of Medicine, May 28, 1894. Printed in the *Medical Record*, November 24, 1894.

Physical Diagnosis and Modern Therapeutics. Read at meeting of Michigan State Medical Society, 1896.

A Case of Renal Phthisis Complicating Pulmonary Tuberculosis. Read at meeting of Grand Rapids Academy of Medicine, March 9, 1896. Printed in the *New York Medical Journal*, July 11, 1896.

A Case of Tuberculosis Involving the Hip-joint, Lungs, Testicles, Inguinal Glands, and One or More of the Vertebrae. Read at meeting of the Michigan State Medical Society, May 14, 1897. Printed in the *Medical News*, October 2, 1897.

A Case of Genito-Urinary Tuberculosis: Necropsy. Read at meeting of Michigan State Medical Society, May 14, 1897. Printed in the *Medical News*, September 4, 1897.

A Clinical Study of the Action of the Nucleins in Tuberculosis. Printed in the *Medical News*, May 22, 1897.

Résumé of One Hundred Cases of Tuberculosis. Printed in the *Medical News*, December 3, 1898.

A Case of Arteriosclerosis: Necropsy. Printed in the *Medical News*, April 1, 1899.

The Prognosis of Pneumonia in its Relation to its Etiology. Read at meeting of the Michigan State Medical Society, May 4, 1899. Printed in the *Medical News*, July 8, 1899.

State Sanatoria for Consumptives in Michigan. Discussion on Tuberculosis at the 35th annual meeting of the Michigan State Medical Society in 1900. Printed in the *Medical News*, December 8, 1900.

An Interesting Case of Splenic Anemia. Read at meeting of the Grand Rapids Academy of Medicine, October 16, 1900. Printed in the *Medical News*, March 23, 1901.

Post-operative Non-septic Leucocytosis and Other Blood Conditions. Read at meeting of the Chicago Pathological Society May 12, 1902. Printed in *The American Journal of the Medical Sciences*, September, 1902.

The Care of the Consumptive Poor, with Especial Reference to the Establishment of a Consumption Hospital in Connection with the County Farm. Read at the annual meeting of the Grand Rapids Charity Organization Society, June 13, 1902. Printed in *The Physician and Surgeon*, August, 1902.

On the Healing of Tuberculosis (Clinical Features). Read at meeting of the Laennec Society. (No date given.) Printed in the *Medical Record*, January 7, 1905.

Sanatorium Provision with Industrial Opportunities for Indigent Consumptives. (By Doctor Herbert Maxon King and Doctor Henry B. Neagle.) Prepared for the Symposium on the Sanatorium Treatment of Consumption at the first annual meeting of the National Association for the Study and Prevention of Tuberculosis, May 19, 1905. Printed in the *Medical News*, October 7, 1905.

Diet in Tuberculosis. Read at second annual meeting of the National Association for the Study and Prevention of Tuberculosis, May 16, 1906. Printed in the *Medical Record*, July 21, 1906.

The Scope and Value of the Sanatorium in the Anti-Tuberculosis Movement. Read at sixth annual conference of Sanitary Officers of the State of New York, October 24, 1906. Printed in the *Medical Record*, December 15, 1906.

Notes of Early Diagnosis of Pulmonary Tuberculosis. Read at meeting of the Third District Branch of the Medical Society of the State of New York, October 22, 1907. Printed in the *Medical Record*, December 14, 1907.

Local Anti-Tuberculosis Societies. Printed in the *Journal of the Outdoor Life*, March, 1908.

The Tuberculo-Opsonic Index in its Relation to the Temperature Curve in Active Tuberculosis, and its Value in Diagnosis in Suspected or Arrested Cases. Printed in the *Medical Record*, July 3, 1909.

On the Construction of an Efficient and Economic Diet in Tuberculosis. Read at fifth annual meeting of the National Association for the Study and Prevention of Tuberculosis, May 13, 1909. Printed in the *Medical Record*, October 16, 1909.

Vaccine Therapy in Tuberculosis in Institutional Practice. Read at a joint meeting of the American Otological Society, the American Laryngological Association and the American Climatological Association at the Eighth Congress of American Physicians and Surgeons, 1910.

Institutional Care of Tuberculosis. Printed in the *Journal of the Outdoor Life*, April, 1910.

Therapeutic Artificial Pneumothorax. (By Doctor Herbert Maxon King and Doctor Charles Wilson Mills.) Presented in abstract at the mid winter meeting of the American Sanatorium Association at the Montefiore Sanatorium, Bedford Hills, New York, December 7, 1912.

Section on "Tuberculosis" for Forchheimer's "Therapeusis of Internal Diseases," issued by D. Appleton & Company in 1913.

A Preliminary Study of the Value of Sanatorium Treatment. Read at the eighth annual meeting of the National Association for the Study and Prevention of Tuberculosis, May 30, 1912.

Exercise as a Therapeutic Measure in Pulmonary Tuberculosis. (By Doctor Charles W. Mills and Doctor Herbert Maxon King.) Read at the tenth annual meeting of the National Association for the Study and Prevention of Tuberculosis, May 7, 1914.

Contribution to the Study of Prognosis in Tuberculosis. Read at meeting of the Laennec Society, May 5, 1916. Printed in the *Bulletin of the Johns Hopkins Hospital*, November, 1916.

THE DIAGNOSIS OF TUBERCULOSIS IN THE MILITARY SERVICE[1]

COLONEL GEORGE E. BUSHNELL

Medical Corps, United States Army

The diagnosis of tuberculosis, especially in its so called incipient stage, may be said to be at present in an unsettled state. It is often taught that the local lesion in pulmonary tuberculosis can be diagnosticated at an exceedingly early stage and that by so doing an almost certain cure can be effected, that it is negligence to permit the diagnosis to be deferred until râles and tubercle bacilli are present. Hence the search for ultrarefined methods of percussion, the exaltation of the importance of various signs, even the breaking away from physical methods with the claim that more or less indefinite symptoms of ill health warrant in themselves the diagnosis of tuberculosis. Several erroneous or unproved assumptions vitiate much of the work which has been done along those lines. These are: 1. That the first tuberculous focus accessible to physical examination is the initial focus of the disease in the body. 2. That the disease has not existed previously because not diagnosticated and that therefore the lesion found is an incipient lesion. 3. That percussion if only practiced with sufficient skill is capable of revealing the existence of an incipient focus of active disease before the advent of râles. 4. That the combination of groups of signs and symptoms which may occur in tuberculosis warrants a positive diagnosis of active tuberculosis, though each group in itself can only justify a probable diagnosis of, or create a suspicion as to tuberculosis.

Now supposing that the methods criticised do indeed lead to the commission of the errors, that active tuberculosis is diagnosticated when no clinical tuberculosis is present and that old and quiescent lesions are mistaken for incipient lesions, what harm results? Manifestly that the patients are obliged to give up work, to spend money that they

[1] Published by authority of the Surgeon General in the *Military Surgeon*, the *Medical Record* and the AMERICAN REVIEW OF TUBERCULOSIS.

can ill afford to undergo unnecessary treatment, to incur the stigma of a disease which causes them to be shunned by the ignorant, that sanatoria are filled with patients who do not need the treatment perhaps to the exclusion of others who do, that the statistics as to methods of treatment and to the curability of the disease are vitiated.

That errors are committed extensively in the diagnosis of tuberculosis is shown by recent utterances in Germany. Meissen (1) says that the fear of being regarded as a poor diagnostician leads to the making of the diagnosis of tuberculosis on uncertain and slight indications. This is the reason why, according to Roepke, 10 per cent of the inmates of German sanatoria are not tuberculous. The percentage, Meissen says, may be considerably greater. At Sanatorium Lyster in 1914, in 124 of 312 patients tubercle bacilli were never found (2). Fraenkel (3) is reported to have remarked that the reason for the errors in the diagnosis of tuberculosis lies, he believes, in the fact that too great value is placed on relatively insignificant findings. Friedrich v. Müller (4) says, "I know not a few cases in which patients have been treated for years for dulness of the apex and have even been to Davos, the autopsy showing normal apices." The writer has been surprised in his professional experience to see upon what slender basis the diagnosis of pulmonary tuberculosis is often made. Now in civil life it may be admitted that in certain cases the guarded diagnosis of pulmonary tuberculosis upon insufficient indications may not be without its justification. The argument would be somewhat as follows: the patient is not well, sanatorium treatment or rest and change of air would benefit him, it is necessary to frighten him to induce him to take care of himself, he is abundantly able to undergo the expense, etc., etc. But in military practice the case is quite different. Here it is just as important to know when tuberculosis does not exist as to make the diagnosis when the disease is present. The examiner's duty to the government requires him not only to exclude from the army men who will cripple its effectiveness and help to swell the pension list, but also to do his part to hold to service those who are not afflicted with manifest disability. It will also be his duty to decide as to the presence or absence of tuberculosis in those about to be discharged and to determine whether or not tuberculosis exists in those recently enlisted, and if it does what the probability is as to the disease having been incurred in line of duty or before enlistment.

The present situation is furthermore one of peculiar difficulty for the

civilian examiner who is wont to accept the statements of his patients at their face value, for among the men whom he will examine for entrance into the military service there will be many of two classes: first, the class of men who know or suspect that they have pulmonary tuberculosis but wish nevertheless to volunteer and are accordingly disposed to conceal their past history and present symptoms. (One must always be prepared for the possibility that consumptives attempt to enlist solely in order to secure treatment and pension.) Second, the class of men who, when it comes to conscription, desiring exemption will be tempted to claim symptoms and to give a history calculated to mislead the examiner. At the present juncture it is of importance that cases of active pulmonary tuberculosis shall not be admitted to the army, not only on account of the efficiency of the army but also to spare the future pension list. And it may become equally important that men who should serve their country shall not be permitted to escape their responsibilities by false statements as to their physical condition.

It may then be laid down as a first principle that the examination must be confined to objective fact, to physical diagnosis. The examiner may indeed listen to the applicant's story, but should not give weight to statements not supported by physical signs. It is usually the case that the diagnosis of pulmonary conditions suffers from the sins of omission of the examiner rather than from a too minute attention to unimportant variations from the assumed normal. In fact not much can reasonably be expected of the examiner in the pressure which attends the enrolment of a large army. There is need of haste and the surroundings are often unfavorable for the practice of auscultation and percussion. All that can be demanded is that cases of well marked manifest tuberculosis shall be detected. There is need of a standard on the one hand to prevent unnecessary rejections for too slight causes or from misapprehended physical signs; on the other hand to guide the hurried examiner and help him to bear in mind conditions which should lead to rejection, yet may easily be overlooked. A standard, if authoritatively adopted, is moreover a great moral support to the examiner, since it relieves him from the responsibility of decision as to the weight which is to be given to the signs which he detects; it tends also to the rendering of justice by favoring equality as respects the treatment of the applicants at the various recruiting stations. The present paper is intended as a contribution to the difficult subject, the

principles which should govern in the examination of the recruit in deciding as to the existence of pulmonary tuberculosis in a form that incapacitates for military service.

The most vexed question is, what is the significance of lesions of the upper part of the upper lobe which are not accompanied by râles? All will admit the frequency of old arrested lesions without râles in this part of the lungs. The point chiefly debated is: are there physical signs which enable the diagnosis of truly incipient tuberculosis of the upper lobe to be made before râles are present? Laennec thought that there are no such signs, that râles are the first indication of the presence of a new focus. Grancher taught that changes in the breathing became apparent before the focus softened and produced moist sounds. His writings have influenced strongly the later authors. Study of properly taken radiographs forces the student to agree with the teachings of the more advanced radiologists who claim that the tuberculous process begins at the hilus, in childhood usually, and spreads through the lung as a peribronchial process, often limited permanently to the deep lung, in less fortunate individuals reaching the periphery and giving rise to clinically manifest tuberculosis. In the vast majority of cases such clinically manifest tuberculosis appears first at the surface of the upper lobes. Radiographs show every stage and all possible variations as to the extent of the process. We see tuberculosis ascending upward and checked while still in the deep lung, or lines terminating perhaps in healed apical foci which have not reached the surface of the lung and are still too deep and too minute to afford certain signs. Again we find lesions that have involved the cortex and have produced a probably at one time manifest and active tuberculosis, which is now arrested, the process having run its course without the knowledge of the subject. And of course we find also lesions of the upper lobe distinctly traceable from the hilus in all stages of present activity. There seems to the writer little question that the manifest tuberculosis of the surface of the lung which the clinician once called the primary lesion of the disease is a relatively late development, that it frequently heals, that the manifest disease at the time that we discover it is frequently a recrudescence or an extension from older attacks. There is therefore no reason why small and obscure lesions of the upper lobe, as truly as large lesions, may not be old lesions, the difference simply being that in the one case the disease has not been brought to the attention of the subject, in the other he has been only too conscious of the struggle

against it. This view is not only the one that is most readily accepted as the result of study of radiographs, it is also the one which best harmonizes and coördinates the facts known as to childhood tuberculosis and the results of animal experimentation. We may then properly inquire, with regard to even the smallest and most obscure of manifest lesions, whether changes in percussion and breath sounds, and other special signs, are signs of a new or of an old tuberculosis?

Everyone will admit that old, dry lesions of the lung exist and that they are recognized by the following signs: dulness[2] on percussion and a respiration characterized by a harshness of quality (broncho-vesicular, rude, verschärft) and a prolongation of expiration. The old dry lesion is a contracting, relatively airless lesion. The preponderance of solid tissue leads to relative dulness and to an increased conductivity of the sounds from the bronchi. Hence the broncho-vesicular quality of the respiration and the prolonged expiration, both due to the fact that the sounds transmitted by the bronchi reach the surface of the lung more distinctly than is normally the case. The increased conductivity may be due solely to the relatively airless condition of the lung involved. This is shown by a simple experiment: Take the lungs, with trachea attached, of a freshly killed pig or calf. Cut off one lung leaving its main bronchus as long as may be. Insert the nozzle of a small bellows into the trachea and tie it in. Close the cut end of the bronchus of the severed lung and work the bellows. Its operation partially inflates the lung, which rises and falls with the working of the bellows. On auscultation with the stethoscope a sound which is of course the sound of the bellows conducted through the lungs, gives a passable imitation of normal breathing. Now open the end of the severed bronchus, continuing the operation of the bellows. The air now escapes in great part through the opening thus provided. The lung collapses to a considerable extent and only slightly expands under the impulse of the indriven air. The respiratory sounds are still to be heard, but their quality has changed, there being an increased harshness of inspiration and a marked prolongation of expiration. The sounds from the bronchi, of the same loudness as before, are no longer muffled by the presence of countless inflated air cells and reach the ear with much greater distinctness.

The increased conductivity may also be due solely or in great part to increase in fibrous tissue. This is illustrated by a recent case. An

[2] For simplicity cavity signs are not here considered.

old man, for many years an inmate of the hospital at Fort Bayard as a beneficiary of the Soldiers' Home, has just died of cardiorenal disease. Although the sputum has always been negative for tubercle bacilli the case has been considered to be one of pulmonary tuberculosis, that is, while the presence of other disease was recognized the patient has been regarded as having pulmonary tuberculosis also to an extent which justified his retention in an institution devoted to the treatment of that disease. There was some difference of opinion among the various examiners as to the extent of the pulmonary disease, some giving undue weight to râles due to other causes, but all agreed that there was an old lesion at the right apex characterized by harshness of breathing and prolongation of expiration and the presence of râles. At the autopsy the lung at this point was adherent by firm and old adhesions. The apex beneath the adhesions was slightly puckered and contracted and there was a small increase of fibrous tissue. The lungs presented no other macroscopic evidence whatever of tuberculosis further than enlarged firm hilus glands. Here the pulmonary adhesions connecting directly with the framework of the lung constituted themselves a speaking tube to transmit more distinctly than normally the sounds of the bronchi. The moist sounds illustrate the bronchial catarrh beneath adhesions of which Bang (5) speaks. We may say then that in chronic lesions the broncho-vesicular quality of the respiration and the prolongation of the expiration are due to the increased conductivity of the lung caused by relative airlessness and by increase of fibrous tissue, both factors in varying degree being generally present.

Of course any condensation of the lung tissue will produce the same result in a more or less marked way according to its nature. The consolidation of pneumonia produces a typical bronchial breathing with prolongation of expiration; in fact the signs are present in this condition in a degree of perfection that is practically never encountered in pulmonary tuberculosis. There is a tuberculous pneumonia. We may encounter this as a comparative rarity and watch it pass through its various stages. But it is a relatively late condition, the result of the confluence of formerly discrete foci, and generally terminates in caseation and cavitation. The patient usually is febrile and unmistakably ill. The process moreover is accompanied by an abundance of moist sounds of a character which varies with the stage. For our present purpose, which is the determination of the signs which demand the rejection of the afebrile, ambulant subject from the military service,

the fact that bronchial breathing is found in tuberculous pneumonia may be disregarded. It remains to inquire whether the physical phenomena which we have ascribed to increased conductivity may be produced in any other manner. Undoubtedly an exaggeration of bronchial sounds by noisy breathing, in which there is an actual prolongation of expiration, may be conducted to the examiner's ear and simulate the conditions which have been described. This is a point to which attention should be paid in examinations. Whether the same or similar phenomena may be produced by other morbid conditions than those considered is another question. Goldscheider says that bronchitis may cause a sharpened inspiration but only on the condition of increased activity of respiration; however, as he goes on to say, we can not conceive of a localized bronchitis as the cause of this phenomenon. Grancher thought that the harshness of inspiration which he regarded the first sign of incipient phthisis was due to minute if not microscopic tubercles at the junction of the respiratory bronchiole with the alveolar passages, which by their presence and by the swelling caused by them effected a partial obstruction of the air current and hence an a teration in the sounds of inspiration. Others have attempted to explain the alterations in respiratory sounds by swelling of the mucous membrane of the bronchi with resulting partial obstruction. The subject is too large to enter upon here in detail. It suffices to say that the various explanations offered are either, like that of Grancher, based upon an obsolete pathology, or err in ascribing too great activ ty of inflammation to chronic tuberculosis. The tuberculous process in the class of cases under consideration so rarely develops acuity of inflammation that the possibility of confusion from the presence of the latter may in practice be safely neglected. This is particularly true of the so called incipient tuberculosis of the apex in which minute attention to respiration is supposed to be capable of detecting the earliest changes. It is a singular fact that even those who describe breath changes as the earliest signs admit that the same changes are present after the case has become chronic. Thus Grancher, after stating that the earliest signs of an incipient lesion are first harshness of inspiration, then harshness of expiration, followed by prolongation of the latter, goes on to say that these signs sometimes persist for a long time. If Grancher's views were correct it would therefore be probable that the lesion would be encountered most frequently in the chronic stage. Goldscheider (6), analyzing a series of cases of apical disease, says that it is impossible to discover any relation

between sharpened inspiration and catarrh, and that the pathological change which was regularly present was induration of the apex and further that a connection between prolonged and sharpened expiration and catarrh is improbable. Râles and crepitation were often found by him without changes in expiration. He often observed, he says, that expiration was prolonged or sharpened on the side of the greater dulness, but not on the side of the lesser dulness (that is, these signs are found more marked over the lesion which is the more indurated, therefore probably the older). He considers that it follows from his observations that sharpness of inspiration and prolongation of expiration depend upon induration of lung tissue.

The writer agrees with Goldscheider that râles and crepitations are often present at the apices unaccompanied by alteration in the character of the breath sounds, which dissociation is usually evidence of a quite recent lesion. With regard to percussion, of which some writers expect so much at the present time, Grancher says (7):

> One should not demand of percussion more than it can give. It is in fact a somewhat gross procedure from which one should expect only summary and simple information. So many causes in fact can modify the sonority of percussion—the position of the percussed finger, the mode and force of percussion, the time of respiration and even the position of the patient—that if in practice we busy ourselves with nuances we shall do a futile thing. Add to these considerations the fact that often a serious pathological condition of the lung produces no appreciable change in the normal resonance.

Meissen expresses a similar opinion. He says (8), speaking of Waller's method of percussion: "In such finesse of percussion, as well as of auscultation, it is not recognized that our physical diagnosis, speaking strictly, is a very coarse procedure which can not possibly give certain information as to slight changes." The writer agrees in general with the above views. But conceding the ability of the expert to detect minutest changes in condensation at the apex, the most serious objection which can be brought against his methods, in the writer's judgment, is their frequent misuse. It is the fashion to-day to assume that the presence of dulness at the apex is an important and early sign of the incipient lesion. But so far as such dulness is due to pulmonary disease in the class of cases under consideration it is a sign merely of induration of the lung. We have seen that there is reason to suppose that, usually, say in nineteen cases out of twenty, induration or condensation at this

place is evidence of increase of fibrous tissue, that is, of an old lesion, not of an incipient lesion, and that with regard to the twentieth case it is one that is not likely to be considered for enlistment. We affirm then that in practice it is the rule that dulness at the apex is not an early but a late sign of pathological changes. A similar view is held by Schneider (9) who says, "The first signs of apical tuberculosis are not to be expected from percussion but from auscultation." Cabot (10) states that in the earlier stages of incipient tuberculosis there may be no recognizable physical signs. The earliest physical signs are fine crackling râles. Osler (11) says that feeble breath sounds are the most characteristic early signs. The expiration is usually prolonged. In other cases the earliest sign is a harsh rude respiratory murmur. With regard to this statement it may be remarked that enfeeblement of respiration without other morbid signs means simply that the lung does not breathe as freely as it should, in other words, pleural adhesions are present—a sign usually of an old lesion. In the absence of other signs, similarly, from the writer's standpoint, the prolonged expiration and the "harsh rude respiratory murmur" are generally evidences of an induration. In general, prolonged expiration and harshness of respiratory sounds are characteristic of the dry lesion. But râles, and indeed râles which seem those of recent inflammation, may be present with these signs. There is no reason why we may not have an old lesion with its classical signs, within which there has been a recrudescence of activity of the tuberculous process so that it may be called, so far as acuity is concerned, a mixed lesion. We shall never understand apical tuberculosis until we are prepared to accept the view that there may be more than one exacerbation in that region, that the lesion which we detect is not by any means necessarily an incipient lesion, even though minute and obscure. The tuberculous process in its stealthy advances sometimes spills over, so to speak, from the deep lung producing a superficial lesion. The immunity of the patient rises, the tide of disease recedes, the superficial lesion heals, to be detected finally by the changes in respiratory sounds chiefly, and to be considered only too often an active rather than an obsolete process. Or again what we have called the tide of the disease, which is, less figuratively, the increase of inflammatory lymph from the deep peribronchial process, again rises and with higher waves and inundates once more the apex producing now more easily perceptible signs, a collection of signs some of which proceed from the old and others from the recent pathological process, a "mixed" process in the sense in which that word is used above.

The earlier manifestations of the pathological process set forth above were long ago described by Bard under the name of abortive tuberculosis of the apex. The writer is inclined to grant a frequent benignity to apical tuberculosis and to suppose that many of the so called non-tuberculous indurations of this region are really *ab origine* tuberculous.

With regard to the general subject under consideration let us cite the views of some of the French authors. Bezançon (12) says, "Diminution of the respiratory murmur, localized and constant at one apex, is a probable sign of tuberculosis, not of incipient tuberculosis but of latent, torpid, attenuated tuberculosis." Bard remarks (13):

> The greater part of the signs which Grancher gives as relating to incipient phthisis apply much more exactly to abortive lesions. Most frequently the existence of abortive lesions is not revealed until their activity is a thing of the past. It is important to be on one's guard against confounding slight with incipient lesions.

Piéry in his brilliant treatise on pulmonary tuberculosis considers diminution of the vesicular murmur and jerky respiration as due to attacks of recurrent pleurisy which has produced partial pleural adhesions in the first case and has left a roughened pleura in the second. He remarks, "At the risk of contradiction we would say that the only early stethoscopic signs are râles." And further he says, "The error of the last thirty years has been to attribute to an incipient tuberculosis what in reality proceeds from an old attenuated, or abortive tuberculosis. From this error have sprung eminently disastrous results in the field of practical medicine."[3]

Perhaps the best proof that the foregoing is correct, or more accurately that the view that incipient foci are to be detected prior to the advent of râles is wrong, is afforded by the following considerations. It is

[3] It is interesting to note the present position of German diagnosticians under the pressure of war conditions. Goldscheider (14) says, "Only active cases of tuberculosis from the army should be taken into sanatoria, such as show fine râles. Insufficient to establish an active process are rough breathing, sharpened breathing, slight apical dulness." The Berlin letter already quoted above states that the need for men has made it necessary to accept for enlistment persons with healed or inactive tuberculosis, but many of them have made excellent soldiers. Open cases of tuberculosis or such as give evidence of an active process must be exempted from military service. On the other hand old inactive cirrhotic forms can under certain conditions be regarded as fit for military service. It will be noted that the quotation from Goldscheider fully supports the position of the writer, namely, that the activity of a tuberculous process is, in military practice, to be determined solely by the presence of moist sounds.

generally recognized that early miliary tuberculosis can not be detected by the aid of physical signs. Friedrich v. Müller (loc. cit.) says:

> It was pointed out in a discussion on the X-ray at Berlin that we can not detect fresh tubercles in the lungs (that is, by means of the X-ray) with the same disappointment that Laennec and Skoda felt when they recognized the fact that *even an extensive miliary tuberculosis presents no perceptible signs to auscultation and percussion* (italics mine).

It is frequently observed that the size of tuberculous foci is found at autopsy to be greater than that determined during life by clinical methods, there being recent extensions of the tuberculous process which have escaped detection. Now if the numerous foci of miliary tuberculosis and the recent small foci surrounding an old lesion can not be discovered in their early stages, what authorizes us to believe that it is possible to detect the *incipient* lesion of the apex by auscultation and percussion before râles have made their appearance?

RÂLES

For an understanding of the writer's point of view it is necessary to say a few words on the subject of râles before describing the tuberculous lesions which will be encountered in exaimnations of the recruit. A complete discussion of the various kinds and the significance of râles would be too extensive an undertaking for the limits of this paper. A brief sketch in which attention is called to a few points is all that can be attempted. The râle in the strict sense is the sound produced by the movement of air within the lungs in the presence of fluid. A dry râle in the literal sense is a misnomer. Either fluid is present or the sound merely simulates the true râle. Râles are of two kinds: râles of acute inflammation and râles of congestion, chronic inflammation or chronic irritation. The acute inflammatory râles of tuberculosis are those which accompany tuberculous pneumonia. They are the classical crepitant and subcrepitant râles of pneumonia in general. It is not necessary to describe the crepitant râle. The subcreptitant râle is equally familiar, but one point should be insisted on. To denote a pneumonic process the râle must be fine, occur in showers during inspiration only, and they must all be of the same size, that is, the râles that occur in showers must all be alike. But the pneumonic process may develop in a region in which other râles are present. Occasionally

râles are heard in showers in large moist lesions which may for that reason be mistaken for the true subcrepitant râle, as for example in a large fibrocaseous lesion of the lower lobe with pleural adhesions which keep it nearly motionless in ordinary breathing. Let the patient suddenly breathe deeply or breathe and cough and the moisture discloses its presence by showers of râles which may appear to be small and of equal size. But they are always larger than the true subcrepitant râle and after the moisture has been disturbed by repeated inspirations the shower effect disappears. Râles which accompany inflammatory or irritative conditions of less acuity than that of tuberculous pneumonia we will denominate indeterminate râles. They differ from the inflammatory râle in that they have no fixed place of origin, no fixed size and are not connected with any definite period of respiration, though more commonly found in inspiration. They are produced by the movement of air through tubes or cavities in which moisture is present and vary according to the size of the container and the amount and the degree of viscosity of the fluid. Usually the indeterminate râle is, as to place of origin, a bronchial râle, as the subcrepitant râle may be called the râle of the bronchiole and the crepitant râle the râle of the alveolus. The important point is that the indeterminate râle is the râle of the chronic stages of tuberculosis. Nothing is more surprising than the failure of many examiners to consider the age of the tuberculous lesion. It is not uncommon to see afebrile or nearly afebrile patients who have been condemned by their physicians to a speedy death in whom the tuberculous process was of an eminently chronic nature and who as a matter of fact live many years after the rendering of the fatal prognosis. The subject is too large a one to consider here in its entirety. What interests us particularly in this connection is the question as to the significance of râles occurring in small manifest tuberculous lesions or in what are suspected to be tuberculous lesions. In the first place the presence of typical crepitant or subcrepitant râles is undoubtedly cause for rejection: there is not only a tuberculous lesion present but that lesion is in an active state. Likewise the indeterminate râle if abundant and easily heard is an indication of a lesion of sufficient activity to demand rejection. On the other hand the so called atelectatic râles of the apex (râles heard on the first full inspiration after quiescence and not repeated in subsequent inspiratory acts), whatever their mechanism may be, are not evidence of an active tuberculous process. Doubt will sometimes arise as to the so called dry râle. As has been remarked, a

dry râle is a misnomer. The causation of the sound thus denominated is obscure, but there is no doubt that it does not indicate active tuberculosis, being heard in patients who remain under observation for many years without developing any active process. In men of apparent vigor such sounds may be disregarded in the absence of other signs. Sometimes vigorous men during the course of a common cold will show rather faint râles at a point in the back below and near the angle of the scapula. These râles usually occur symmetrically on both sides and are distinguished from tuberculous râles by this fact and by the absence of changes in percussion note, breath sounds and transmission of voice. In cases of doubt the examination of the subject should be deferred. Occasionally scanty, rather coarse, mucous râles persist for a long time in lesions which are old, fibrous and practically obsolete, the subject being in apparently vigorous health. Here the râles are not necessarily true tuberculous râles. They may denote moisture effused in a damaged area from causes other than tuberculosis, that is, arthritism, as shown by the fact that they are sometimes caused to disappear by a course of Carlsbad salts or other purgative. We are here, however, on debatable ground. The candidate should be rejected unless his qualifications make him especially desirable for some special duty, in which case note should be made of the condition and authority to waive it obtained. Sounds resembling râles, known as marginal sounds (15), are frequently to be heard in the healthiest men at the base of the lungs during inspiration, especially in the axilla. They are sometimes heard only upon one side, sometimes upon both sides. They are caused by the separation of the pleural surfaces as the edge of the lung penetrates into the complemental space and are not of pathological significance. They are distinguished from true râles or friction sounds at this location, with both of which they are frequently confounded, by their strict limitation to the border of the lung and by the absence of other signs and symptoms.

During strong respiratory movements and especially after cough the bending of the sternum produces fine crepitations which may be propagated a short distance to the surrounding lung, or, more frequently, reach the observer's ear if the stethoscope touches the edge of that bone. These are not often mistaken for signs of disease. More liable to cause mistakes are sounds originating in the costosternal articulations. These occur in a most marked degree in athletic men, strong breathers, who have perhaps strained the articulations of the thorax by violent exercise. The sounds sometimes much resemble moist râles, but may have

a more "bony" quality. Being occasionally propagated several inches along the rib their determination requires care (16). Of course the absence of other signs and the health of the subject should put the examiner upon his guard.

THE NON-ADVANCING, SHARPLY DEMARCATED CHRONIC TUBERCULOUS FOCUS

Percussion shows dulness which stops abruptly at a certain level. The line below which the note becomes normal can be drawn accurately. Mark this line and it will be found that râles, if present, are heard down to it and not beyond it. Vocal fremitus and resonance, increased above it, return to normal below it. The more marked the dulness the older the lesion; the sharper the line of demarcation between dulness and normal resonance the longer the time during which the lesion has ceased to advance; the harsher the respiration and the more prolonged the expiration the greater the amount of condensation, the older the lesion. The drier the lesion the less is its activity. The râles, usually elicited with difficulty, as only by expiration and cough, are indeterminate râles. If the lesion is absolutely dry it may be called arrested. Such a lesion implicates especially the superficial lung, the sharpness of demarcation being due to fibrous encapsulation, the distinctness with which the auscultatory sounds are perceived being probably due to the presence of pleural adhesions which bind the parenchymatous fibrous tissue of the lung firmly to the thoracic wall. It is not infrequently complicated by the presence of a cavity. As above described the lesion has been one of sufficient intensity to make it probable that there is considerable deep tuberculosis. It is therefore a cause for rejection even though absolutely dry.

THE ADVANCING CHRONIC TUBERCULOUS FOCUS

The advancing chronic tuberculous focus is characterized by dulness which shades into normal resonance, by râles which extend below the zone of dulness, by a lack of correspondence as to level between the percussion note and the transmission of voice. The râles heard may be all indeterminate or indeterminate above and subcrepitant below, indicating then pneumonic extensions below an older lesion. Such a lesion is of course a cause for absolute rejection.

The superficial lesions just described are the result of a failure of immunity during the original extension of tuberculous lymphangitis to the apex, which has led to the development of numerous superficial parenchymatous tuberculous foci, discrete and small foci of tuberculous pneumonia. If they remain discrete they may become arrested and clinically the signs of fibrosis predominate. If they coalesce in their entirety or in part by reason of a secondary caseous pneumonia a cavity forms. With return to a relatively high immunity the sharply demarcated lesion results.

THE DEEP ACTIVE PERIBRONCHIAL LESION

But in some cases the failure of immunity shows itself not by the development of a localized pneumonic process but by the conversion of the tuberculous lymphangitis into what is usually called peribronchial tuberculosis, but which more accurately is a series of peribronchial invasions of the parenchyma, a ring of tuberculous pneumonia about the bronchi. This process varies in severity. The more severe forms do not concern us at present. The less severe forms are capable of arrest but are dangerous because not readily localized, and difficult of diagnosis on account of the obscure physical signs which they present. In the advanced consumptive we generally find a cavity with old fibrosis above and peribronchial extensions of a secondary nature, the result, that is, of later exacerbations, below. But in the young adult the process may be confined to the deep lung. In cases of men at all eligible for enlistment by reason of apparently fair health the process will be largely limited to the paravertebral region. It may give no signs of its presence. It may be suspected by the presence of indistinct râles which seem distant, found perhaps in the second and third interspaces anteriorly near the sternum. In its progress the process ultimately develops the classical apical tuberculosis or may instead produce superficial lesions at the summit of the lower lobe which may extend down the edge of the lower lobe and appear as pneumonic foci or cavities near the inner edge or under the angle of the scapula, a region which should be carefully examined in the young especially. Another common form is peribronchial extension in the side opposite to the primary superficial lesion. When the second lung is involved the process may be that of the typical superficial lesion, but it may also take the form of peribronchial tuberculosis. Superficial examination detects the pri-

mary lesion. The other side appears to be normal, but on expiration and cough moist indeterminate râles are heard perhaps over the entire anterior surface of the lung extending into the axilla. The only other sign present may be high pitched "short" percussion note. Such cases are likely to escape attention if the method of expiration and cough is not employed. They are of course to be absolutely rejected.

Peribronchial extensions to the lower lobe result rarely in extensively disseminated and numerous deep small foci which manifest themselves to clinical examination only by a high pitched "short" note on strong percussion, by increased vocal fremitus (sometimes only produced by sounding a deep bass note) and sometimes by indistinct distant râles. In the more marked cases there is also a characteristic loss of expansion of the affected side, the deep lung being too stiff to expand freely. The X-ray throws much light on this class of cases which may otherwise escape detection. In view of the difficulties which attend the rapid diagnosticating of such cases, it is a good rule to look with suspicion upon cases in which the subject shows constitutional depression, marked signs of ill health, with only a small and apparently unimportant superficial lesion. If the general condition is impaired to a degree disproportionate to what might be expected from the manifest lesion it is not unlikely that there is a well marked deep tuberculous process, a supposition often confirmed by the radiograph.

THE CHRONIC HEALED PERIBRONCHIAL TUBERCULOSIS

Hitherto we have considered only the signs of peribronchial tuberculosis in an active state. But this disease in its less severe forms often heals leaving changes in the lungs which are not infrequently misinterpreted. Tuberculous peribronchial lymphangitis may be said to heal invariably; that is, if the tuberculous process is one of any marked acuity it will pass beyond the lymph channels and invade the parenchyma. Confinement of the tuberculosis to the lymph channels of the peribronchial tissue is therefore a sign of a high immunity or, if you prefer, a benign form of the disease.

The X-ray frequently shows in the cases of apparently healthy persons thickening of the bronchi, though no active tuberculosis may be present. The tuberculous nature of the thickening is demonstrated with great probability by the presence of more or less sharply marked dots in the network of the lines. There are however many cases in which the dots

are scanty or absent, while the characteristic restriction of the abnormal opacities to the paravertebral region of the upper lobe justifies the assumption that the process has been of a tuberculous nature. We infer then that in such cases the thickening of the lines has been due to a tuberculous lymphangitis now healed or quiescent which has led to the formation of fibrous tissue in the peribronchial tissue and to a fibrous thickening of the outer coats of the bronchi. No doubt the process frequently advances to the formation of true tubercles in the peribronchial tissues which also become obsolete in persons of high resistance. However that may be, the tuberculous process has produced a sufficient induration in the vicinity of the air tubes to permit the transmission with greater than normal distinctness of the respiratory sounds in the bronchi in cases in which the fibrous tissue advances nearly or quite to the surface of the lung. The result of the indurative process is the production of broncho-vesicular breathing over the part affected. The process may be entirely obsolete or may be still active; all that the broncho-vesicular breathing shows is the presence of an induration. The question of activity is determined by the presence or absence of râles. If disseminated râles are present the examiner need go no farther in order to decide upon rejection.

The cases, however, that present the greatest difficulty are those in which the lung is dry. We have to decide what bearing broncho-vesicular breathing has upon the acceptance of the applicant. Sometimes this breathing is found in men of apparently excellent health, as for example a case which came recently under the writer's notice.

An officer of middle age, ruddy and tanned, in good flesh, with strong muscles, presented himself for treatment for tuberculosis. The diagnosis of tuberculosis had been made in 1911, but he had ignored it, had served a tour in Alaska and afterwards returned there for a hunting trip and had been on full duty ever since, part of the time on the border in command of a light battery of artillery. An operation for removal of the tonsils in February, 1917, led to an examination of the sputum and tubercle bacilli were found in it. There were well marked signs of active but not recent tuberculous lesions in both upper lobes. Auscultation showed harsh breathing and prolonged expiration over almost the entire right lung anteriorly and over the greater part of the left lung. Posteriorly the same breath changes were found down to the vicinity of the seventh dorsal vertebra on both sides. In view of the good physical condition of the patient and of the fact that they extended to about

the same level on both sides it seemed improbable that these breath sounds were of much significance, but the radiograph showed heavy streaked shadows extending throughout almost the entire lung. Here was a case of peribronchial tuberculosis, a fibrosis, which had developed to an enormous extent and gone on to healing, without interfering with the patient's work or play for a single day until, at least six years after the incipiency of the tuberculosis, the disease was discovered almost by accident during an exacerbation in the parts of the lung most severely involved.

Similar findings, usually less extensive, are not infrequent in soldiers from the Philippine Islands, whose condition is discovered as a result of hemoptysis or of sputum positive for tubercle bacilli, but who on arrival at Fort Bayard may be found to have already arrested the activity of their disease. Slight changes in the breath sounds accompanied sometimes by slight alterations in the pitch of the percussion note are the only physical signs of a process which, though healed, is always to be taken seriously and should, if extensive, constitute a cause for rejection. The typical lesion of the consumptive, the well marked focus of the upper lobe, is by origin a broncho-pneumonia developed in the extension of a deep peribronchial tuberculosis. The deep tuberculosis may become arrested and the superficial focus may become strictly limited or it may extend downward through the superficial lung. But on the other hand the peribronchial tuberculosis may extend, sometimes benign, sometimes most acute and fatal, through the other parts of the affected lung or of both lungs. We must be prepared to expect every possible variation as respects the extent and severity of the process. We must also be prepared to diagnosticate it on seemingly slight grounds, disseminated râles in the acute process, the breath sounds already described in the healed process, with slight change in the percussion note, both signs, with dulness on percussion, in the active chronic process. Failure to understand and recognize peribronchial tuberculosis as a more or less independent process as well as a concomitant of the localized superficial lesion is one of the commonest of the mistakes made in the diagnosis of tuberculous lesions.

TUBERCULIN

It is well recognized that a positive reaction to tuberculin, especially in the young adult, is not a proof of the presence of active, clinically important tuberculosis. Tuberculin only demonstrates activity of the

tuberculous process in the clinical sense when it can be shown to produce a focal reaction. Such reaction is not without danger. One indication for the employment of tuberculin which is always understood but not always set forth with the distinctness that is desirable in so important a matter is that the physician who uses it should be capable of an exact diagnosis of the pulmonary condition in order that he may not use it under conditions where fatal harm may ensue. Nothing is more dangerous than to place so powerful a reagent in unskilled or careless hands. Since therefore tuberculin rarely leads to a correct diagnosis and may do injury its general use in the diagnosis of tuberculosis in examinations for enlistment should be prohibited.

X-RAY

Only well marked pathological changes are revealed by radioscopy. For the accurate diagnosis of tuberculosis recourse should always be had to the study of the X-ray negative. It is not of course practicable to use radiography extensively for the determination of tuberculosis during the examination of recruits. But the X-ray will doubtless be often employed in doubtful or disputed cases so that it is necessary to consider the rules which should obtain in reading the radiograph.[4]

As Cohn says, morbid changes in the lungs are shown by shadows due to two substances: first, blood; second, fully organized connective tissue (17). Blood imprints a shadow on the negative only when present in abundance. The congestion of lobar pneumonia is typical. Broncho-pneumonia of tuberculous origin may also cast shadows, but only when the process is acute, the congestion great. Frequently the tuberculous process runs so chronic a course that the inflammatory reaction is insufficient to congest the lung enough to produce a shadow. The shadow of congestion is not sharply outlined, it melts away at its borders.

Connective tissue in the parenchyma of the lung away from the hilus is not normally present in sufficient quantity to retard appreciably the passage of the X-rays except as it occurs in connection with and as a part of the various tubes, bronchi, blood vessels and lymphatics. As a result of proliferative inflammation connective tissue develops as a fibrous thickening of these tubes, particularly the bronchi and the lymph vessels, which casts a shadow deeper than normal; the older the process and the better organized

[4] The paragraphs in the smaller type are extracted from a paper read December 8, 1916, before The Southwestern Medical and Surgical Association, which appeared in the issue of May, 1917, of *Southwestern Medicine*.

the tissue, the denser the shadow and the sharper its outline. Tubercle, caseations as such, cast no shadows distinguishable from the other tissues of the parenchyma. Cohn (loc. cit.) found that cubes, 1 cc. in size, of caseous tubercles when embedded in a healthy lung were indistinguishable by the X-ray. But if the caseations become calcified or are even impregnated abundantly with mineral salts they become opaque to the X-ray. . . . .

In general, and especially if we are dealing with the shadows of tubes, we may say that fuzziness of outline means acute vascular congestion, an active process. On the other hand when the shadows of the tubes are sharp we have a process which if active at all is at least not characterized by great acuity, is not congestive. Stuertz speaks of what he calls *dry* tuberculosis of the lung tissues, which inclines to abundant formation of connective tissue, to dry caseations and cicatrizations or to complete transformation into fibrous tissue, as characterized by sharply outlined granular spots and by more or less sharply marked bands and streaks (18). We would call especial attention to the persistence of the sharply outlined dots and lines when tuberculous activity no longer exists. We can not emphasize too strongly the point which is so frequently overlooked, that the sharply outlined thickenings of the bronchi and other tubes may be evidence of an old inflammation now entirely obsolete, may be simply records of the ancient history of the pulmonary tuberculosis.

We do not see tubercles in the X-ray negative. What we see is either sharply outlined calcifications and fibroses, or fuzzy congestions, or a combination of the two conditions. Cohn (loc. cit.) states that he has seen cases in which the X-ray in general gave the same findings in both lungs while autopsy proved one lung severely, the other slightly, diseased. Such cases illustrate well the limitations of X-ray diagnosis. What Cohn saw in the X-ray negative was probably the thickened framework of old inflammation in the two lungs, in one accompanied by much parenchymatous disease of recent origin, in the other accompanied by little, the said parenchymatous disease being invisible to the X-ray because neither sufficiently congested nor sufficiently organized to cast shadows.

We do not then see tubercle as such any more than we see tubercle bacilli in the X-ray; we see only the results of tuberculous inflammation. It is necessary to insist upon this point because failure to appreciate it has been the cause of much faulty diagnosis.

Friedrich Müller (loc. cit.) says: "The exaggerated expectations once had for the X-ray illumination have not been fulfilled. It is the experience that fresh and not extensive inflammatory processes, as some broncho-pneumonias, or recent tuberculous infiltrations, escape the X-ray negative."

Extensive systems of lines, many sharply outlined spots, dense streaks, do not then show an acute process. Persons in good health with nearly or quite arrested tuberculosis are sometimes found by the X-ray to present a picture of very extensive changes of this kind. Yet the prognosis in such cases is not good if the subjects be subjected to severe strain. The radiograph is a proof that the lungs have undergone serious changes. The danger is either that hardship will lead to a reactivation of the numerous more or less quiescent tuberculous lesions or, if the process has been largely of the nature of fibrosis, that the lungs have been so damaged thereby as to unfit the person for an active life. If then the radiograph shows extensive dappled or mossy shadows or numerous spots and streaks the recruit should be rejected however good his health may appear to be. Shadows of a homogeneous opacity result from pleurisy and are not necessarily a cause for rejection in the absence of other signs.

Tuberculosis of the bronchial glands is a diagnosis often made from the radiograph on very slight foundation. The fact is that pronounced swelling of the lymph glands is characteristic of primary, not of advanced tuberculosis. It is rare that intrathoracic gland tuberculosis is of any clinical importance in the adult. Hamburger (19) says: "With few exceptions cases of bronchial gland tuberculosis which lead to true symptoms of disease are confined to the first and second year." Philippi (20) is inclined to exalt the importance of bronchial gland tuberculosis in his elaborate study of that affection, but admits: "It must be remembered that only rarely, especially in adults, is it a purely glandular process; rather is it a more or less pronounced disease of the surrounding hilus tissue in the form of peribronchial and infiltrative processes of the neighboring pulmonary tissues." In other words the interscapular dulness relied upon for the diagnosis of enlarged glands, if caused by lung conditions, is due to tuberculous processes in the region of the hilus, participation in which to any important extent on the part of the glands is a matter of conjecture. The presence of masses in the neighborhood of the hilus as shown by the X-ray may indeed be cause for rejection, but rejection on account of relatively small opacities in that region on the ground that they indicate a bronchial gland tuberculosis of clinical importance certainly should not be permitted.

RÉSUMÉ OF INDICATIONS FROM X-RAY NEGATIVES

The X-ray shows: 1. Tuberculous disease confined to region of hilus in deep lung. 2. Extension upward towards apex or downward and outward towards base, confined to deep lung. 3. A fine line or two extending to apex with or without small focus or foci there; condition not determinable by physical signs. 4. Clouding of apex without marked lines from hilus, probably largely pleuritic. 5. Well marked lines extending to superficies of apex, usually, but not necessarily, with foci there; lesion accessible to physical examination. 6. Lines extending towards shoulder as well as apex: (a) If confined to deep lung may mean early and now obsolete exacerbation; (b) If extending to superficies denote larger lesion and less immunity than 5. 7. More or less widely diffused spots, lines and streaks through a considerable portion of lower lobe approaching periphery of lung, with few or no auscultatory signs; deep peribronchial tuberculosis. 8. More extensive streaked opacities involving greater part of one or both lungs and extending to periphery with few or many physical signs; fibrocaseous tuberculosis, fibrosis preponderating in proportion to scantiness of more or less rounded spots or dots.

Conditions as shown by 1, 2, 3, 4 and 6 (a) are not causes for rejection. Cases under 5 to be determined by physical examination. Cases under 6 (b), 7 and 8 are to be rejected.

DEVELOPMENTAL DEFECTS

The various developmental defects, the paralytic thorax, the scaphoid belly, prominent scapulae, the dropheart, the enteroptotic type, denote arrest in the regular evolution of the body which may be due to tuberculosis in the early years of life. While some "slabsided" men are vigorous and make excellent soldiers, abnormal configurations such as above mentioned, associated with apparent delicacy, constitute a cause for rejection even though no definite disease is discovered. Such types are always well represented at Fort Bayard. Examiners are altogether too careless in accepting such men for enlistment. It is safer to take a chance on a vigorous and athletic man with a well developed chest though there be signs of an old, not too large pulmonary lesion, than to accept frail creatures who can manifestly never endure great fatigue, though free from signs of actual disease at the time of examination.

EXAMINATION BY COUGH

This paper is not a treatise on physical diagnosis, but there is one procedure in physical examination which deserves a few words of explanation. Reference has already been made to the method of "expiration and cough." It is best executed as follows: starting from the state of rest of the lung the subject forcibly expels the air from the lungs, reserving the last portion of the expiration for a short cough, after which inspiration immediately follows, but only enough air is inhaled to return the lung to the state of rest. The idea is to diminish the size of the bronchi as much as may be by expiration, then to cough to stir up forcibly such fluid as may be present in them. The moisture is more likely to be moved by the current of air and so produce râles when the tubes are of their least caliber. This procedure should by all means be resorted to by all who attempt to diagnosticate pulmonary tuberculosis. It is also necessary for the successful study of marginal sounds and sternal sounds.

PHYSICAL EXAMINATION

The physical examination for the presence of pulmonary tuberculosis as practised by the specialist with a view to determine the precise extent, age and probable prognosis of the lesions, including as it should a careful record of past history and of all abnormal signs present, is a time consuming affair. For military purposes, however, in which the object is to reject from further consideration cases with well marked positive findings, much can be omitted from the examination and its duration can be correspondingly abbreviated. All that is absolutely necessary is to determine the presence of a tuberculous lesion of sufficient size and activity to constitute a cause for rejection. This can be done in well marked cases of active tuberculosis in a few minutes, in some cases in half a minute. To demonstrate the absence of disease naturally requires a longer time.

A recommendation having been made several years ago to the effect that experts in lung diseases be stationed at recruiting depots in order to examine the incoming recruits and exclude those affected with tuberculosis before their acceptance, it was objected by higher authority that the examination of each case would necessarily be so prolonged that it would be impracticable to go over the lungs of any considerable number of men within the time that could be allotted for the work.

In order to determine the time requisite for a preliminary examination a test was arranged with the coöperation of Major E. H. Bruns, Medical Corps. Annex number one at Fort Bayard is what would ordinarily be called the receiving ward. To it are admitted all incoming patients on the status of enlisted men, except those who arrive *in extremis*. The cases that prove to be very advanced or require surgical treatment are transferred to the Enlisted Men's Infirmary. Those who have some fever or who for any other reason are thought to need bed treatment, nursing or special observation are retained at annex number one. The incoming patients who are in the best condition are transferred to annex number two, where they are kept under observation for as long a time as is deemed necessary in the individual cases before being transferred to the wards for ambulant patients. Major Bruns kindly selected 25 of these cases for the test. None of the cases was known to the examiner, but they had been carefully examined, most of them more than once by his assistants and the results of the examinations had been recorded upon the case cards. These cases were examined by the writer by the auscultatory method aided by percussion, auscultation of voice, etc., whenever thought necessary, the object being to determine the least time which was necessary to get an approximation to the correct diagnosis. The time consumed for the whole examination was one and one-half hours. No special effort was made to shorten this time, which was spent to a considerable degree in consulting the case cards after the examination had been completed in the individual cases, in waiting for patients to remove their clothing, etc. The actual time of physical examination was fifty-eight minutes, the time for each patient varying from one and one-half to two and one-half minutes. The diagnosis, not only as to the presence or absence of tuberculosis but also as to the extent of the lesions present, was made correctly as determined by comparison with the cards in twenty-two cases; in two cases the presence of an old pleurisy in which there had been effusion at an earlier time was not recognized, and in one case a cavity was erroneously diagnosticated by carelessness in failing to notice that the patient was breathing noisily. The patients were as a rule afebrile. In most of them there were no signs of present activity; in one there was no evidence of clinical tuberculosis. They were, in short, such cases as might very well have been presented to the examiner of recruits. Of course a diagnosis made with such speed is more or less a "snap" diagnosis and the method is not recommended for universal adoption except as a preliminary exami-

nation to select cases that may appear doubtful for later and more thorough study. Still the results were more accurate than had been expected and show, it is thought, unmistakably that a sufficiently correct diagnosis to exclude cases of manifest and active tuberculosis from the army can be made very quickly. This may seem to some asking too little of the examiner, but the writer honestly believes, in view of the considerable percentage of cases admitted to Fort Bayard with large and manifestly chronic lesions after brief service in the army, that if all recruits were examined with no more care than was given to the examination above reported the number of patients treated at Fort Bayard would be reduced by at least one-fourth and very probably by a much larger percentage.[5] The importance of these considerations in view of the magnitude of the contemplated army does not need to be emphasized.

RAPID DIAGNOSIS BY AUSCULTATION

The subject, stripped to the waist, is instructed to breathe somewhat more rapidly and deeply than normally, avoiding noisy respiration and relaxing the shoulder muscles as far as possible. The examiner, standing in front of the subject, applies the stethoscope first to the lower axillary region. If breathing is harsh and expiration is prolonged on both sides, the subject is not breathing properly. Regulate the breathing until the breath sounds are normal on one or both sides, and charge the subject to continue to draw each breath with exactly the same force and rhythm throughout the examination. In case abnormal breath sounds are found it is necessary to return frequently to the point over which the breathing has been found normal in order to be sure that the character of the breathing has not been changed by the subject. The subject breathing satisfactorily, we find: A. The breath sounds are alike in both axillæ; B. The breath sounds are louder upon one side than the other. Proceeding under A, the examiner goes upward anteriorly, comparing symmetrical points on both sides, noting carefully the character of the inspiration, the character and especially the length of the expiration, comparing the breath sounds frequently if in doubt with the ascertained normal point. If râles are present in the upper axilla concentrate the attention on the affected side, pass upward rapidly with the stethoscope, have subject breathe out and cough. Râles heard in the axilla will be heard with greater distinctness above. In

[5] See paper by the writer in *Journal Association of Military Surgeons*, xix, 5, November, 1906.

case of râles disseminated through the upper lobe, reject. If the lung is dry, proceed systematically upward with the auscultation. A lesion of the upper lobe will show either râles or changes in breath sounds (according to its acuity) by the time the third rib is reached in the great majority of cases. Note character of breathing with especial care from this level upward. An old lesion will show harsh breathing and prolonged expiration more marked as one ascends, with or without râles. Continue to auscultate to and above clavicle. If breathing is found to be abnormal repeat the auscultation while the subject breathes out and coughs. (See Topical Variations, 1, 2 and 3.) An active lesion (that is, one with râles) is in general a cause for rejection, but an occasional râle *without changes in breath sounds* is not sufficient cause for rejection. We proceed under B. The breath sounds are distinctly louder upon one side than upon the other.

(a) The louder side has normal breath sounds; a pulmonary lesion, pleural adhesions, or both conditions on the other side. Examine the latter side for pulmonary lesions. Have subject cough. Pass round to the back; if râles are present over an extended area, reject. Further corroboration, if necessary: dulness on percussion, increased vocal resonance and fremitus. (Less common in the ambulant subject is dulness with diminished or absent vocal fremitus: 1, pleural effusion; 2, very thick adhesions over parenchymatous lesion. If 1, vocal resonance is absent or very feeble, breath sounds are absent or distant, no râles elicited.[5] If 2, there is dissociation of vocal resonance and fremitus; vocal resonance is present, fremitus absent or diminished, râles generally present after cough, breath sounds absent or distant. Conditions 1 and 2 are causes for rejection.)

(b) The louder side has harsh breathing, prolonged expiration; not usual in this location. Concentrate on this side, pass round to back, examine for râles. If rapid search over lower lobe shows no abnormal signs, proceed upward anteriorly as under A. If signs of lower lobe lesion are unmistakable, it is a cause for rejection.

Examination of back. Secure normal breath sounds right base (see Topical Variations, 8). Proceed upward comparing symmetrical points. If harsh breathing and prolonged expiration heard between scapulae (see Topical Variations, 9) are abnormal, the signs will increase in distinctness as one proceeds upwards. When these signs are detected test with expiration and cough, if râles are present,[6] reject (but see

[6] But râles may be present above the level of the effusion.

remarks, page 336). If breath sounds appear normal go over back when subject exhales and coughs, to eliminate recent disseminations of tubercle. If disseminated râles are present, reject. (For right apex, see Topical Variations, 1.)

Cavity signs. Harsh respiration, much prolonged expiration sometimes distant and low-pitched, with cavity quality; cough usually produces characteristic râles; vocal resonance and whisper characteristically increased. A cavity unmistakably present is cause for rejection.

TOPICAL VARIATIONS OF NORMAL SIGNS

1. Harsh breathing, slightly prolonged expiration over right apex posteriorly, without other signs, is not cause for rejection (proximity of bronchus). The same signs anteriorly over the right apex if slight are not necessarily pathological.

2. The same signs second interspace right anteriorly close to sternum are not a cause for rejection (proximity of right main bronchus). If these signs are found outward and downward from this point they indicate a lesion.

3. Increased vocal resonance and slightly harsh breathing immediately below center of left clavicle are occasionally found. They do not indicate a lesion in the absence of other signs.

4. Fine crepitations over sternum or heard when stethoscope touches edge of that bone are not pathological.

5. Clicks heard during strong breathing or after cough in the vicinity of the costosternal articulations (below the first) in the absence of other signs are not indicative of a lesion.

6. Sounds resembling râles at base of lung, especially in right axilla, are not pathological if strictly limited to the base and to inspiration and not accompanied by other signs.

7. The same is true of sounds resembling râles over the lingula (heart apex) heard on cough.

8. Prolonged expiration at left base posteriorly, limited to this region, is not abnormal.

9. Slightly prolonged expiration at about the angle of the scapula, *disappearing a short distance above this point,* is not a sign of a lesion, if alike on both sides (transmission from normal bronchi) and not accompanied by other signs.

REFERENCES

(1) MEISSEN: Internat. Zentralblatt f. d. gesammte Tub. Forschung, ix, No. 11, p. 500.
(2) MEISSEN: Internat. Zentralblatt f. d. gesammte Tub. Forschung, ix, No. 12, p. 561.
(3) FRAENKEL: Berlin letter, Jour. A. M. A., February 3, 1917, p. 364.
(4) v. MÜLLER: Zeitschr. f. ár tl. Fortbildung, ix, 14, July 15, 1912, p. 417.
(5) BANG: Internat. Zentralblatt, f. d. gesammte Tub. Forschung, ix, No. 8, p. 375.
(6) GOLDSCHEIDER: Zeitschr. f. klin. Med., 1909–10, lxix, p. 205.
(7) GRANCHER: Maladies de l'Appareil Respiratoire.
(8) MEISSEN: Internat. Zentralblatt f. d. gesammte Tub. Forschung, ix, No. 7, p. 333.
(9) SCHNEIDER: Deutsche med. Wochenschr., 1915, 32.
(10) CABOT: Diagnosis.
(11) OSLER: Practice of Medicine.
(12) BEZANÇON: La Revue de la Tuberculose, xiii, No. 5, May 1908, p. 357.
(13) BARD: Quoted by Piery, La Tuberculose Pulmonaire, p. 676.
(14) GOLDSCHEIDER: Berl. Klin. Wochenschr., 1915, 44 and 45, Internat. Zentralblatt, ix, No. 12, p. 541.
(15) BUSHNELL: N. Y. Medical Record, December 21, 1912.
(16) BUSHNELL: N. Y. Medical Record, January 20, 1912.
(17) COHN: Zeitschr. f. Tuberkulose, xvii, 3, 1911, p. 217.
(18) Muench. med. Wochenschr., 26, July 1, 1913.
(19) HAMBURGER: Allgemeine Pathologie u. Diagnostik d. Kindertuberkulose.
(20) PHILIPPI: Beiträge zur Klinik d. Tuberkulose, xxi.

THE PLEURAL REACTION TO INOCULATION WITH TUBERCLE BACILLI IN VACCINATED AND NORMAL GUINEA PIGS

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In attempting to do some experimental work with pleural effusions, it was found that the pleural cavity of rabbits, inoculated with virulent tubercle bacilli after a pneumothorax had been established, did not respond to the inoculation with the development of fluid. It was further discovered that a second inoculation of bacilli into the same pleural cavity some weeks later resulted in a rapid accumulation of bloody serous exudate, rich in leucocytes. A somewhat similar observation has been made by Cleaveland Floyd (10) who found by experiment that when the pleura was sensitized for some days, the response to infection with pyogenic organisms was in the nature of a purulent effusion. The problem was therefore suggested as to whether a sensitization of the pleura prior to inoculation was necessary for the development of an effusion and whether this sensitization might not be a part of a general change in reaction produced by an already existing tuberculosis.

It has been known for some years, though it is comparatively recently that its importance has been recognized, that an animal already tuberculous reacts to an inoculation with tubercle bacilli differently from a normal control. Koch (1), Trudeau (2), and Römer (3) were among the first to recognize this fact. Since these observations the difference in reaction has been studied in several organs and tissues of experimental animals. The skin, the tissue on which Koch based his first observation, has been more thoroughly investigated by Römer and Joseph (4) and Rist and Rolland (5). The peritoneal reaction to reinfection has been studied by Rist, Rolland and Kindberg (6) and by Manwaring and Bronfenbrenner (7). Soper, in the Saranac Laboratory, is at present investigating the liver reaction, and the course of reinfection in the lungs has been studied by Trudeau (2), Krause (8) and Bezançon and de Serbonnes (9). It is the object of the present experiment to study

and determine the differences in reaction, following the inoculation of virulent tubercle bacilli into the pleura of normal guinea pigs and of those which have been previously vaccinated with bacilli of low virulence and as a result have developed a localized glandular tuberculosis and show a tuberculin sensitiveness.

TECHNIQUE

A series of guinea pigs was inoculated subcutaneously in the right groin with 0.5 cc. of a fairly thick, opalescent emulsion of slightly virulent tubercle bacilli, strain R1.[1] These animals show a skin reaction to tuberculin in from two to three weeks after infection. A similar number of normal animals was selected to be used as controls. Three weeks or more after the vaccinating dose, the animals, vaccinated and controls, were given 2 cc. of an emulsion of virulent tubercle bacilli, strain H37[2], into the right pleural cavity. The method of giving the pleural inoculation is as follows: The animal is held on its left side by an assistant with the fore legs stretched above the head. The right side of the thorax is shaved and a small hole is made with a von Graefe eye knife through the skin over one of the upper intercostal spaces. A syringe with a blunt pointed needle is used for making the inoculation. The needle is inserted into the skin puncture and is forced through the intercostal fascia and pleura. After a few trials the pleural cavity is easily entered without any damage to the underlying lung. Some of the animals were killed in pairs, a vaccinated and a control, by bleeding at various intervals of time after the intrapleural inoculation, while others were allowed to live until the infection caused death.

RESULTS

The response to the intrapleural inoculation in the vaccinated animals is immediate and marked. One hour after inoculation there is found some hemorrhagic exudate which is greater in amount than the fluid injected. This increases from day to day, reaching a maximum at

[1] R1 is a strain of human tubercle bacilli, isolated in 1891 by Dr. E. L. Trudeau. It has lost much of its original virulence for guinea pigs during the course of cultivation and now causes only localized disease at the point of inoculation and in the regional glands. It does not spread or cause general disease and inoculated pigs have survived for more than two years.

[2] H37 is a virulent strain of human bacilli which becomes generalized in guinea pigs and as a rule causes death in from four to six weeks.

the eighth or tenth day after which it is rapidly absorbed (see fig. 1). The fluid may be so great in amount as to cause definite dyspnoea (guinea pig 33). When the fluid is present in considerable amounts, 10 cc. or over, the surface of the lungs presents a wrinkled appearance from compression (see fig. 2). The character of the fluid varies accord-

FIG. 1. LUNGS OF GUINEA PIGS KILLED NINE DAYS AFTER VIRULENT INTRAPLEURAL INOCULATION

Upper vaccinated pig, lower normal control. The fluid has been absorbed in the vaccinated animal but the surface of the lungs is covered with a large amount of fibrin. There is no fibrin on the pleura of the control.

ing to the amount of bacilli injected, but individual animals exhibit differences, probably due to a greater or less degree of sensitization. As a rule large doses, 0.001 gm. or over of dried bacilli, will cause a hemorrhagic effusion which at times resembles pure blood, while with smaller doses the exudate is serous, faintly blood-tinged or turbid (table 1).

With the development of the effusion there is also a marked production of fibrin which is deposited on the pleural surfaces, both visceral and parietal, giving them a shaggy appearance. In every case in which fibrin was present a considerable amount was found in the interlobar fissures. As the effusion is absorbed the two pleural layers become adherent to one another by this fibrin so that in some cases the pleural space is completely obliterated (see fig. 3). Eventually much of this fibrin is absorbed leaving a smooth pleural surface while some becomes organized into fibrous tissue and remains permanently as firm fibrous

TABLE 1

Results of varying dosage

NO.	VACCINATED	INTRAPLEURAL	DOSE	KILLED	FLUID	CHARACTER
				days		
51	March 23, 1917	April 14, 1917	0.001	2	8 cc.	Serous, considerable fibrin in both pleurae
52	March 23, 1917	April 14, 1917	0.0001	2	5 cc.	Bloody in both pleurae, some fibrin
53	March 23, 1917	April 14, 1917	0.00001	2	Few drops	Serous, right pleura
54	March 23, 1917	April 14, 1917	0.000001	2	Few drops	Serous, right pleura
55	March 23, 1917	April 14, 1917	0.0000001	2	None	
56	March 23, 1917	April 14, 1917	0.001	4	15 + cc.	Very bloody, much fibrin, both pleurae
57	March 23, 1917	April 14, 1917	0.0001	4	12 + cc.	Serous, slightly bloody, some fibrin
58	March 23, 1917	April 14, 1917	0.00001	4	5 cc.	Slightly bloody, no fibrin
59	March 23, 1917	April 14, 1917	0.000001	4	None	No fibrin
60	March 23, 1917	April 14, 1917	0.0000001	4	None	No fibrin

adhesions. In nearly every case the opposite pleura shows the same changes as the one into which the bacilli are inoculated.

The fibrin is not exuded evenly from the whole pleural surface, but from small areas on which the bacilli lodge. This was best seen in our rabbits with pneumothorax in which the pleural surfaces were not in contact. In these animals, microscopically, the fibrin had the appearance of a mushroom with a short stalk, the base of which was attached to the pleura. In the pulmonary tissue, immediately beneath was found an infiltration of leucocytes.

In the control animals there is little or no immediate pleural reaction. With excessive doses, 0.002 gm. or over, there may be a small amount of fluid and fibrin produced, but it is invariably less than in the vaccin-

ated animals and does not always occur, while with smaller doses there is no exudation and no adhesions unless the lung has been injured by the needle during the inoculation, in which case a localized traumatic pleurisy develops, with one or a few fine fibrous adhesions as an end re-

FIG. 2. LUNGS OF GUINEA PIGS KILLED FIVE DAYS AFTER VIRULENT INTRAPLEURAL INOCULATION

Upper vaccinated pig, lower normal control. Vaccinated animal shows wrinkling of lungs from pressure of fluid, 16.5 cc. Also roughening of pleura from fibrinous exudate. Pleura of control is smooth and lungs are distended.

sult (pigs 12C and 37C). In a few controls some serous fluid was found to develop after the second week. This probably represents a sensitization of the pleura by the inoculation so that a multiplication of the bacilli in this allergic pleura would act similarly to a reinfection.

FIG. 3. THORAX OF VACCINATED GUINEA PIG KILLED SEVEN DAYS AFTER VIRULENT INTRAPLEURAL INOCULATION

The pleura contained 15 cc fluid. Thick fibrinous adhesions are seen in both pleurae.

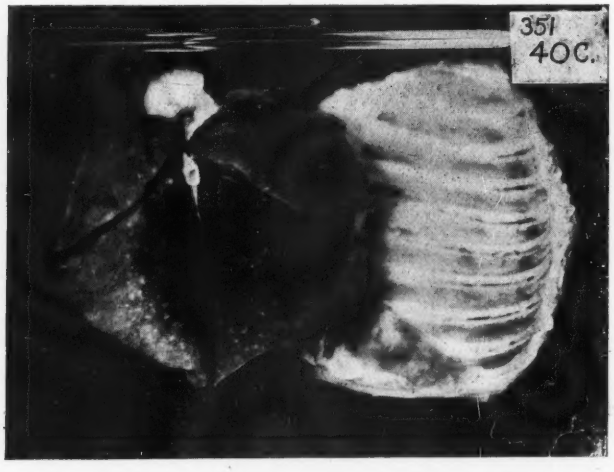

FIG. 4. END RESULT IN A CONTROL GUINEA PIG WHICH DIED SEVENTY-NINE DAYS AFTER VIRULENT INTRAPLEURAL INOCULATION

The lungs are studded with small miliary tubercles. The visceral pleura is smooth. There are some subpleural tubercles on the parietal pleura.

Within twenty-four hours after the pleural inoculation all the vaccinated animals appear sick, their fur is roughened, breathing is rapid, they do not eat and they lose their natural liveliness. A small percentage did not recover from this state and died within two weeks (pigs 26, 27, 28, 43). It was at first thought that death might be due to suffocation from excessive accumulation of fluid but the condition of the liver and spleen seemed to indicate a death from intoxication. These deaths were certainly not due to the operation for we had absolutely no opera-

FIG. 5. END RESULT IN A VACCINATED GUINEA PIG WHICH DIED ONE HUNDRED AND THIRTY-THREE DAYS AFTER VIRULENT INTRAPLEURAL INOCULATION

The lungs are filled with large fibro-caseous tubercles. The pleura is glistening and there are no adhesions. The picture is one of a chronic tuberculosis.

tive mortality among the non-vaccinated animals, which showed no ill effects whatever following the inoculation. Those vaccinated animals which survived the first two weeks and were allowed to live regained their normal healthy appearance and lived for seventy days or more while the control animals died in from twenty-eight to thirty-five days on an average. Three of the controls, pigs 27C, 40C, 28C, lived sixty-seven, seventy-nine and ninety-two days respectively but are exceptions to the general rule. Autopsies on the control animals showed an acute

disseminated tuberculosis (see fig. 4). The vaccinated animals gave an entirely different picture, the tuberculosis being of a chronic fibroid type (see fig. 5). Table 2 illustrates these differences.

Examination of the effusions showed that the leucocytes were at first exclusively polymorphonuclears. Later on lymphocytes and macro-

TABLE 2

Comparative length of life after inoculation in vaccinated and control animals

VACCINATED			CONTROLS		
Pig number	Length of life	Remarks	Pig number	Length of life	Remarks
	days			*days*	
26	7	20 cc. fluid	6 C	25	No adhesions
27	7	20+cc. fluid	10 C	28	Adhesion at point of inoculation
28	10	10 cc. fluid	8 C	36	One adhesion, right lung
43	14	25 cc. fluid	13 C	30	Few pleural tubercles
49	27	Cause of death, acute pneumonia	14 C	36	Adhesion at point of inoculation
6	28	Pneumonia (?)	20 C	31	No adhesions
9	73	Tuberculous meningitis	38 C	31	Adhesion at point of inoculation
14	78	Generalized chronic tuberculosis	26 C	36	Pleura negative
13	82	Generalized chronic tuberculosis	39 C	39	Pleura negative
10	115	Generalized chronic tuberculosis	27 C	67	One adhesion, right pleura
18	133	Generalized chronic tuberculosis	43 C	32	Acute pneumonia
38	111	No adhesions in pleura	44 C	36	No adhesions
39	123	Generalized chronic tuberculosis	45 C	36	Acute pneumonia
50	94	Generalized chronic tuberculosis, many adhesions	28 C	92	Chronic tuberculosis, few fine adhesions
40	141	Still living	40 C	79	No adhesions
44	141	Still living			
45	141	Still living			

phages appeared and the polymorphonuclears gradually disappeared. A varying proportion of red blood cells was always present. After the first few hours tubercle bacilli were not found at all or in very small numbers. In microscopic sections the bacilli could be found enmeshed for many days in the fibrin on the lung surface. The fate of the bacilli is discussed more fully further on.

The results described are considered to be typical of the reactions in vaccinated and control animals. In the course of the work a few animals were found which did not conform to this general picture, but the number of animals used, over 100, seems sufficient to justify certain general conclusions. The atypical results may be explained in part by unsuitable dosage or irregularities in technique, such as failure to introduce the whole dose into the pleura or trauma to the underlying lung, or intercurrent infections, as acute pneumonia accompanied by a plastic pleuritis, of which we had an epidemic in our guinea pig room during the past winter. In the pigs which died as a result of this pneumonic infection, Gram positive diplococci could usually be demonstrated in smears from the pleural exudate and in sections of the lungs.

DISCUSSION

We will not enter into a lengthy discussion of the mechanism of the altered reaction to infection in animals already tuberculous as the work is as yet only in its initial stages and many problems have arisen during the course of this experiment which require further investigation. Taken in conjunction with similar studies on other tissues and organs by other investigators in the Saranac Laboratory and elsewhere it seems justifiable to suggest that the explanation may lie in an allergic condition of the fixed tissue cells, this allergy being produced by an already existing focus of disease in some other part of the body. Manwaring and Bronfenbrenner (7) in their study of intraperitoneal lysis of tubercle bacilli concluded that such lysis is not due solely to substances in the circulating fluids but is apparently due to specific changes in the fixed peritoneal cells of the tuberculous animals. Another explanation might be offered by those who favor the humoral theory of immunity, namely that the virulence of the injected bacilli is lessened by the action of the serum of the effusion in such a manner that the tissues would react differently to these attenuated bacilli than they would to an implantation of unaltered virulent bacilli. Such a theory, however, does not explain why there is an exudation in the tuberculous and not in the normal controls which is the fundamental and primary difference in the reactions. We also found that the effusions contained virulent bacilli capable of causing disease in normal animals. This will be discussed at greater length further on. The reaction of the pleura to slightly virulent bacilli, strain R1, and also to virulent bacilli, strain H37, killed by

heating at 50°C. for four hours, was tested. The results did not correspond to those obtained in the vaccinated animals. Both groups showed some acute pleural reaction in the first twenty-four hours, but this was slight and transient and would probably be produced by the introduction of any foreign irritant, a solution of gentian violet giving a much more marked reaction in two pigs tested. The bacilli are absorbed and within thirteen days the mediastinal lymph nodes are found enlarged. The ultimate result of these inoculations is not yet known as some of the animals are still living (on May 1, over one hundred and fifty days). The pleura in the last animals killed, seventy days, was quite normal in appearance. We feel justified in concluding from these facts that the action of the body fluids on the injected bacilli will not alone explain the results and that some other factor or factors must be active.

The response in the vaccinated animals to the pleural inoculation is an immediate intense local reaction which is of the nature of an acute inflammation, being characterized by dilatation of the vessels, exudation of serum and fibrin and a local polynucleosis. This characteristic reaction is not found in the control animals in which the pleura shows no immediate changes. This reaction tends to localize the bacilli, large numbers being enmeshed in the fibrin and held, while others are probably diluted by the exudate so that absorption is more gradual. Thus fewer bacilli are disseminated to other parts of the body and this dissemination takes place more gradually. It is also possible that some of the bacilli are destroyed or rendered harmless by the serum before leaving the pleura. Those bacilli which are absorbed by the pleural lymphatics and are carried to other parts of the body are in turn arrested in tissues, likewise rendered allergic by the primary inoculation, with the result that the lesions in these differ from those in the control animals, being of a more chronic nature as evidenced by the greater length of life of the animals and by the condition of the organs which are voluminous and firm and show a tendency to fibrous tissue development. In the controls the tuberculous lesions are smaller and correspond to those of an acute miliary tuberculosis, being approximately in the same stage of development in the various organs. Death, as a result of this acute tuberculous condition, occurs with remarkable regularity from the fourth to the sixth week. The suggested explanation of these observations is that there is no local response to inoculations in

normals such as is found in vaccinated animals, and, this defense failing, absorption and dissemination take place rapidly.

As to the fate of the bacilli after inoculation into the pleura we are not as yet in a position to express a definite opinion. Some are absorbed, others are phagocyted by the polynuclear leucocytes and macrophages or are enmeshed and held in the fibrin. What becomes of those which remain free in the effusion, or do any so remain? After the first few hours very few or no bacilli, either phagocyted or free could be found in the effusions but these same effusions were found to be virulent for and to infect normal guinea pigs in every case when inoculated subcutaneously, as long as any fluid was found in the pleura, as is shown in table 3, which gives briefly the results of the inoculations of the effusions. This does not correspond to the findings of Rist, Rolland and Kindberg (6) who experimented with peritoneal exudates from reinoculated animals and found that the inoculation of the "allergic exudate" failed to produce tuberculosis in 7 out of 12 guinea pigs. Manwaring and Bronfenbrenner (7) noted the disappearance of bacilli from the peritoneal fluids in tuberculous animals but did not report any inoculation experiments. The localized nature of the disease produced by the inoculation of some of these effusions suggested the possibility of a lowered virulence of the bacilli. Cultures were therefore made from the gland pus of animal 22 Test and an emulsion from these cultures was injected subcutaneously into two guinea pigs. One pig died forty-six days after the injection and autopsy showed widespread tuberculosis such as is found after subcutaneous inoculation with H37. The second pig was killed one day later, and showed generalized tuberculosis of the spleen, liver and lungs, thus confirming the picture in the former. This proves to us that the virulence of the H37 strain has not been lessened by the action of the effusion. We have been able to demonstrate acid-fast bacilli microscopically in the masses of fibrin adhering to the lungs and particularly in the interlobar fissures as long as one hundred and eleven days (guinea pig 38) after the intrapleural inoculation which shows that the bacilli are not all destroyed locally but may retain their shape and staining properties for a long period of time. Our results correspond to the common clinical experience that fluid from a tuberculous pleurisy will cause tuberculosis in guinea pigs although no bacilli can be demonstrated microscopically even after careful and repeated search. Whether the bacilli are too few in number to be found or are held in and concealed by flakes of fibrin or whether there is a non-acid-fast form of the bacillus,

TABLE 3

Virulence of effusions

PIG NUMBER	FLUID FROM PIG	DAYS AFTER REINOCULATION	INOCULATION	METHOD	KILLED	AUTOPSY
21 Test*	21	1	Nov. 14, 1916	Subcutaneous	Dec. 27, 1916	Right inguinal gland caseous: deep iliac glands +, spleen tuberculous: acid-fast tubercle bacilli in pus
21 Test	21	1	Nov. 14, 1916	Intraperitoneal	Dec. 27, 1916	Tuberculous inguinal glands
22 Test	22	3	Nov. 16, 1916	Subcutaneous	Dec. 28, 1916	Inguinal glands caseous: acid-fast tubercle bacilli in pus
22 Test	22	3	Nov. 16, 1916	Intraperitoneal	Dec. 28, 1916	Spleen tuberculous
23 Test	23	5	Nov. 18, 1916	Subcutaneous	Jan. 10, 1917	Inguinal glands caseous: spleen, two small nodules
23 Test	23	5	Nov. 18, 1916	Intraperitoneal	Jan. 10, 1917	Spleen slightly tuberculous
24 Test	24	7	Nov. 20, 1916	Subcutaneous	Jan. 10, 1917	Caseous abscess, right groin: spleen tuberculous: few foci in lungs
24 Test	24	7	Nov. 20, 1916	Intraperitoneal	Jan. 10, 1917	Spleen slightly tuberculous: few foci in lungs
25 Test	25	9	Nov. 22, 1916	Subcutaneous	Jan. 10, 1917	Inguinal glands +: spleen, one nodule
25 Test	25	9	Nov. 22, 1916	Intraperitoneal	Jan. 10, 1917	Spleen tuberculous: liver probably tuberculous
29 Test	29	11	Dec. 5, 1916	Subcutaneous	Jan. 19, 1917	Generalized tuberculosis (killed with one cc. old tuberculin, injected intraperitoneally)
29 Test	29	11	Dec. 5, 1916	Intraperitoneal	Jan. 19, 1917	Generalized tuberculosis: serous effusion in both pleurae
36 Test	36	11	Dec. 6, 1916	Subcutaneous	Jan. 22, 1917	Generalized tuberculosis
36C Test	36C	11	Dec. 6, 1916	Subcutaneous	Jan. 22, 1917	Generalized tuberculosis
30 Test	30	13	Dec. 7, 1916	Subcutaneous	Jan. 22, 1917	Generalized tuberculosis
30C Test	30C	13	Dec. 7, 1916	Subcutaneous	Jan. 22, 1917	Generalized tuberculosis

* Test after number means that the test fluid was obtained from the pig of the corresponding number.

as Much contends, which thus escapes detection by ordinary staining methods we will not say as we are now engaged in some experimental work concerning this point.

What is the main channel of absorption of bacilli after inoculation into the pleura? This is still an unsettled question. Fleiner (11) considered that the lymphatics of the costal and mediastinal pleura play the chief part. Hamburger (13) and Grober (12) emphasize the physical factors of respiration as exerting a pumping or suction action on the costal lymphatics. Meyerstein (14) concludes that the flow of lymph is from the lungs towards the parietal pleura and therefore that the parietal lymphatics and not the pulmonary are chiefly responsible, while Naegeli (15), the most recent investigator of this subject, maintains that the lungs themselves play the most important rôle in absorption from the pleura. While our work has not been carried out with the object of investigating this point and does not prove that either the one or the other set of lymphatics is wholly or chiefly active in the absorption of the inoculated bacilli, the following facts appear quite definite. Infection of the opposite pleura is almost invariable, probably directly through the mediastinum which is very thin, so that both pleurae are about equally involved. The lymph nodes of the mediastinum, both anterior (substernal) and posterior, are early infected. The mediastinal tissues, especially in the vaccinated animals, show marked thickening and in some cases abscesses are found in this locality. In a few animals definite tubercles were found in the parietal pleura following the course of the lymphatics along the line of the ribs. These facts point to absorption by the mediastinal and also by the costal pleura, the lymphatics of which drain into the anterior and posterior mediastinal lymph nodes. On the other hand in a few animals microscopic sections of the lungs showed subpleural tubercles, containing bacilli which give the impression that an implantation of bacilli on the visceral pleura has led to absorption and development of these lesions in the pulmonary tissue immediately beneath. The importance of the respiratory movements appears indisputable. In almost every case fibrin containing bacilli has been found in the sulci between the lobes of the lungs and in many cases where neither fibrin nor bacilli could be found elsewhere in microscopic sections both have been found in the deeper portions of these sulci.

This work helps us to understand etiologically the clinical development of pleurisy with effusion, which is generally considered and spoken

TABLE 4

Summary of animals killed

PIG NUMBER	VACCINATED	PLEURAL INOCULATION	KILLED	DAYS	FLUID	CHARACTER	FIBRIN	ADHESIONS	REMARKS
1	July 24, 1916	Aug. 31, 1916	Aug. 31, 1916	1 hour	2 cc.	Hemorrhagic			
1C		Aug. 31, 1916	Aug. 31, 1916	1 hour	Few drops	Less hemorrhagic			
2	July 24, 1916	Aug. 31, 1916	Sept. 1, 1916	1	10 cc.	Hemorrhagic			
2C		Aug. 31, 1916	Sept. 1, 1916	1	1 cc.	Thinner			
21	Oct. 11, 1916	Nov. 13, 1916	Nov. 14, 1916	1	10+cc.	Clear serous			
21C		Nov. 13, 1916	Nov. 14, 1916	1	Few drops	Slightly bloody			
31	Oct. 11, 1916	Nov. 24, 1916	Nov. 25, 1916	1	6–7 cc.	Serous	+		
31C		Nov. 24, 1916	Nov. 25, 1916	1	0				
3	July 24, 1916	Aug. 31, 1916	Sept. 2, 1916	2	5 cc.	Hemorrhagic	++		
3C		Aug. 31, 1916	Sept. 2, 1916	2	2 cc.	Less bloody			
46	Dec. 10, 1916	Jan. 13, 1917	Jan. 15, 1917	2	5 cc.	Hemorrhagic			
22	Oct. 11, 1916	Nov. 13, 1916	Nov. 16, 1916	3	16 cc.	Slightly hemorrhagic	++		Fluid in both pleurae; pericardium contains fluid and fibrin
22C		Nov. 13, 1916	Nov. 16, 1916	3	0				
32	Oct. 11, 1916	Nov. 24, 1916	Nov. 27, 1916	3	18 cc.	Bloody	++		Lungs compressed by fluid
32C		Nov. 24, 1916	Nov. 27, 1916	3	0		0		
4	July 24, 1916	Aug. 31, 1916	Sept. 4, 1916	4	Pleura filled	Almost pure blood	+++		
4C		Aug. 31, 1916	Sept. 4, 1916	4	Few drops	Slightly bloody			
41	Dec. 10, 1916	Jan. 6, 1917	Jan. 10, 1917	4	Few drops	Bloody			Pneumonic (nontubercular) patches in lung

41C		Jan. 6, 1917	Jan. 10, 1917	4	0				
42	Dec. 10, 1916	Jan. 6, 1917	Jan. 10, 1917	4	Few drops	Bloody			Pneumonic (nontubercular) patches in right lung
42C		Jan. 6, 1917	Jan. 10, 1917	4	0				
16	July 24, 1916	Oct. 12, 1916	Oct. 17, 1916	5	10+cc.		++	Both plurae, fibrinous	In both pleurae
16C		Oct. 12, 1916	Oct. 17, 1916	5	0				
23	Oct. 11, 1916	Nov. 13, 1916	Nov. 18, 1916	5	16.5 cc.	Bloody	++		Both pleurae
23C		Nov. 13, 1916	Nov. 18, 1916	5	0		0		
33	Oct. 11, 1916	Nov. 24, 1916	Nov. 29, 1916	5	29 cc.	Bloody	++	Many, fibrinous	Animal very dyspnoeic; lungs compressed
33C		Nov. 24, 1916	Nov. 29, 1916	5	0				
47	Dec. 10, 1916	Jan. 13, 1917	Jan. 18, 1917	5	15 cc.	Bloody			Lungs compressed
24	Oct. 11, 1916	Nov. 13, 1916	Nov. 20, 1916	7	18 cc.		+++		Both pleurae
24C		Nov. 13, 1916	Nov. 20, 1916	7	0		0	0	
34	Oct. 11, 1916	Nov. 24, 1916	Dec. 1, 1916	7	20 cc.	Cloudy serous	+	Fibrinous	Lungs much compressed: spleen large and soft
34C		Nov. 24, 1916	Dec. 1, 1916	7	0		0	0	
48	Dec. 10, 1916	Jan. 13, 1917	Jan. 20, 1917	7	15 cc.	Bloody	++	Fibrinous	
20	July 24, 1916	Oct. 12, 1916	Oct. 21, 1916	9	Small amount		++	Many, fibrinous, right lung	
18C		Oct. 12, 1916	Oct. 21, 1916	9	2 cc.			Delicate; at point of inoculation	
25	Oct. 11, 1916	Nov. 13, 1916	Nov. 22, 1916	9	6–7 cc.		++	Fibrinous, both pleurae	
25C		Nov. 13, 1916	Nov. 22, 1916	9	0		0	0	
35	Oct. 11, 1916	Nov. 24, 1916	Dec. 3, 1916	9	0		++	Fibrinous	
35C		Nov. 24, 1916	Dec. 3, 1916	9	0		0	0	

TABLE 4—Continued.

PIG NUMBER	VACCINATED	PLEURAL INOCULATION	KILLED	DAYS	FLUID	CHARACTER	FIBRIN	ADHESIONS	REMARKS
17	July 24, 1916	Oct. 12, 1916	Oct. 23, 1916	11	0		++	Dense right: slight left	
17C		Oct. 12, 1916	Oct. 23, 1916	11	0		0	0	Lungs studded with tubercles
29	Oct. 11, 1916	Nov. 24, 1916	Dec. 5, 1916	11	0		0	0	Abscess in mediastinum
29C		Nov. 24, 1916	Dec. 5, 1916	11	10 cc.	Sero-sanguineous			Acute pneumonia with pleurisy: diplococci in lungs
36	Oct. 11, 1916	Nov. 26, 1916	Dec. 6, 1916	11	2 cc.	Bloody			
36C		Nov. 26, 1916	Dec. 6, 1916	11	1 cc.	Serous			
30	Oct. 11, 1916	Nov. 24, 1916	Dec. 7, 1916	13	5 cc.	Bloody	++	Many fibrinous	Mediastinum thickened and contains caseous masses
30C		Nov. 24, 1916	Dec. 7, 1916	13	10 cc.	Very hemorrhagic	++	Right pleura filled with adhesions and fluid	Acute pneumonia with pleurisy (nontuberculous): spleen large and friable
11	July 24, 1916	Sept. 30, 1916	Oct. 13, 1916	14	0		++	Dense in both pleurae	Caseation and pus in mediastinum: abscess in chest wall at point of inoculation
11C		Sept. 30, 1916	Oct. 13, 1916	14	0		0	Few fine adhesions at point of inoculation	
5	July 24, 1916	Aug. 31, 1916	Sept. 15, 1916	16	0		+++	Fibrinous	Pleura almost obliterated

5C		Aug. 31, 1916	Sept. 15, 1916	16	0			0	
12	July 24, 1916	Sept. 30, 1916	Oct. 17, 1916	18	0			Both pleurae obliterated	Caseous foci in mediastinum
12C		Sept. 30, 1916	Oct. 17, 1916	18	8 cc.	Clear serous		Few fine adhesions, right pleura	Generalized tuberculosis
37	Oct. 11, 1916	Nov. 25, 1916	Dec. 13, 1916	18	0		++	Fibrinous	
37C		Nov. 25, 1916	Dec. 13, 1916	18	5 cc.	Serous	0		Some nodules on pleura, which contain tubercle bacilli
15	July 24, 1916	Sept. 30, 1916	Oct. 19, 1916	20	0		++	Right pleura obliterated	Spleen slightly enlarged
15C		Sept. 30, 1916	Oct. 19, 1916	20	0		0	One at point of inoculation	Spleen and liver tuberculous
7	July 24, 1916	Sept. 5, 1916	Sept. 29, 1916	24	0		++	Dense, both pleurae obliterated	Diaphragmatic pleura thickened: caseous foci in mediastinum
7C		Sept. 5, 1916	Sept. 29, 1916	24	0			One at point of inoculation	Generalized tuberculosis
8	July 24, 1916	Sept. 5, 1916	Oct. 3, 1916	29	0			Both pleurae obliterated	Pus foci in mediastinum: abscess in chest wall at point of inoculation
8C		Sept. 5, 1916	Oct. 3, 1916	29	Small amount	Serous		At point of inoculation	Generalized tuberculosis

Numbers alone indicate vaccinated animals.
Numbers followed by letter "C" indicate normal controls.

of as primary and as preceding, sometimes by years, the development of tuberculosis elsewhere in the body. Our experiments show that such tuberculous effusions are not primary but are due to a reinfection either from within or from without, such infection taking place in a pleura rendered allergic by an already existing focus of infection. The inoculations which take place clinically must be small in the number of bacilli relatively to the size of the human body and are not comparable to the enormous dosage used in our experimental work, yet even with these huge masses of bacilli we fail to get an exudative reaction in normal animals. The small clinical infections must therefore be implanted on sensitized tissue in order to produce an effusion. The rapid accumulation of fluid in the pleura is also to be explained by the acute response to infection seen in the sensitized animals.

A similar explanation seems to be justified for the effusions so commonly found in cases of artificial pneumothorax. By the induction of the pneumothorax the lymph flow of the lungs is so altered that it is not difficult to imagine the bacilli being shed from the diseased lung into the pleura more readily than under natural relationships. It is also possible that bacilli may enter the pleura by the tearing of adhesions. Such bacilli enter a pleura altered by the existing disease and an exudate results, the character of the exudate, serous or purulent, depending on the number of bacilli.

SUMMARY

1. Intrapleural inoculations of tubercle bacilli in tuberculous guinea pigs result in an exudation of serum, leucocytes, red blood cells and fibrin.

2. Similar inoculations in normal guinea pigs elicit no noticeable pleural reaction.

3. The acute pleural reaction in tuberculous animals tends to localize the infection which is rapidly disseminated in normal controls.

4. The length of life after intrapleural inoculation is much greater in tuberculous than in normal guinea pigs.

5. The effusions are capable of causing tuberculosis in normal guinea pigs although no bacilli can be found.

6. Tubercle bacilli are probably absorbed through both the parietal and visceral pleura.

7. Fibrous adhesions are formed by the organization of the fibrin.

8. Clinical pleural effusions are caused by the infection of an allergic pleura.

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REFERENCES

(1) Koch, R.: Deutsche med. Wchnschr., 1891, xvii, 101.
(2) Trudeau, E. L.: N. Y. M. J., 1903, lxxviii, 105.
(3) Römer, Paul H.: Beitr. z. klin. d. Tuberk., 1909, xii, 185.
(4) Römer, Paul H. and Joseph, Karl: Ibid., 1910, xvii, 287.
(5) Rist and Rolland: Ann. de Méd., 1914, ii, 13.
(6) Rist and Rolland and Kindberg, M. Leon: Ibid., 1914, i, 312, and 375.
(7) Manwaring, W. H. and Bronfenbrenner, J.: J. Exp. Med., 1913, xviii, 601.
(8) Krause, A. K.: Nat. Ass. Study and Prev. Tuberc. Tr., 1916.
(9) Bezançon, Ferdinand and de Serbonnes, H.: Ann. de Méd., 1914, i, 149.
(10) Floyd, Cleaveland: Tr. Am. Climat. Ass., 1914, xxx, 205.
(11) Fleiner, Wilhelm: Virchow's Arch. f. path. Anat., 1888, cxii, 282.
(12) Grober, Jul. A.: Beitr. z. path. Anat. u. z. allg. Path., 1901, xxx, 267.
(13) Hamburger: Brit. M. J., 1895, ii, 1287.
(14) Meyerstein, W.: Beitr. z. klin. d. Tuberk., 1912, xxiv, 19.
(15) Naegeli: Zeit. f. d. ges. exper. Med., 1913, i, 164.

THE PUBLIC HEALTH WORK OF A GREAT LIFE INSURANCE COMPANY[1]

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The subject upon which I have been asked to speak pertains to the public health work of one of the large life insurance companies, but it may be well to discuss briefly the relation existing between life insurance companies in general and the public which they serve, in order that we may better understand the opportunities of insurance companies for health betterment, which are now beginning to be appreciated and utilized.

The insurance of human lives has been practiced in some form or other from very early times. Doubtless there was a large element of chance in the medieval days when man was constantly subjected to dangers of many kinds which lurked everywhere, and the rates of insurance were presumably high. Furthermore the average length of life was fifteen to twenty years less than now and man was ever beset with the calamitous contagions and plagues that swept barren many of the communities, making the indemnifying of lives a hazardous occupation at best. With the practical disappearance of scourges and with the gradual tabulations of community death rates the gambling elements diminished and it became possible to establish life insurance on a definitely scientific basis.

The early days of life insurance in America were necessarily devoted to the establishment of the business on a firm financial basis. Mortality tables were based upon the mortality experiences of the various companies and it was probably far from the thoughts of the organizers of these companies that there would be material changes in the tables as time went on. This was before the epochal discoveries of Pasteur, Koch, Lister and Virchow had revealed the causes and pathology of diseases which were later shown to be preventable and through the prevention of which human lives could be prolonged. Modern sanitation

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and hygiene were unknown. To be sure the prospective insurance risk was given a medical examination which would detect many conditions prohibiting the granting of insurance, but this was the main, in fact, sole operation tending to secure lives with a reasonable prospect of longevity, and this, it must be said, was made for the protection of the company and the other policy holders. Reasonably it may be supposed that the rejection of thousands of individuals unfitted for life insurance led many of these individuals to have further examinations made and treatment instituted which resulted in an extension of life, but this was largely incidental at that time as far as the policy of the companies was concerned.

The scientific advances in bacteriology, pathology and physiological chemistry made in the latter half of the nineteenth century were all of material benefit to the life insurance companies. With their aid positive and correct diagnosis became more frequent. The examination of sputum for tubercle bacilli by the examining physician and in the companies' laboratories became a routine. Thus open cases of tuberculosis were detected with certainty, and the differential diagnosis of other relatively harmless pulmonary conditions was made possible. Likewise as the study of pathologic material of all kinds became general, the accuracy of life insurance mortality tables became relatively great. Not long after these discoveries practical application was made of them in medical circles, and soon the influence extended to the public in the form of improved methods of disease prevention and treatment. This application was made by national, state and municipal governmental bodies, and included such measures as the protection of watersheds, the securing of pure milk, the isolation of contagious diseases, the importance of early diagnosis of certain diseases, etc. In some diseases, as diphtheria, there resulted a prompt lowering of the death rate, while in the others the reduction was gradual, and the lowered mortality has obviously assisted the insurance companies to a favorable construction of mortality tables and has added protection to the insured.

During the past few years a rapidly increasing recognition of the possibility of further improvement of the public health has been made by many insurance companies and advantage has been taken of the many opportunities to convey to the policy holders messages of health and disease prevention. With the Metropolitan Life Insurance Company this public health work began at home, that is, it started with the employees. The company realized that any messages to policy holders,

to be made effectual, ought to be conveyed by one who has personally had the opportunity to observe the application of the principle that "an ounce of prevention is better than a pound of cure." Naturally, in speaking of the various activities of the company I shall mention some that do not pertain directly to the antituberculosis campaign, but these activities all have a bearing on the health and welfare of individuals and indirectly do aid in the prevention of tuberculosis.

The working force of the Metropolitan Company comprises 19,000 individuals of whom 5000 are engaged at the home office. This is largely a clerical force, 14,000 comprising the field force, which is occupied wherever the company transacts business throughout the United States and Canada. In point of time the welfare work of the company began in 1893, when lunch room facilities were provided for the home office employees. In 1904 lunches were furnished to women employees at cost, and four years later free lunches for male and female employees were provided at the home office. This practice still continues and at present over 5000 lunches are served daily. This step was taken as a practical business measure to provide a wholesome meal for the employees. It was believed that many minor illnesses occurring during the working hours, particularly during the latter part of the day, resulted from improper or inadequate food, and that a wholesome midday meal would increase the working capacity of employees. The results indicate that this belief was well founded and needless to say the general health of the employees was also bettered by this action.

In order to provide the home office employees with opportunities to better their conditions, many of them being dependent entirely upon their own efforts, stenographic classes, classes in English, French and German, sewing and millinery classes, have been organized from time to time, which the employees may attend without cost. A library of 15,000 volumes is provided for the use of the employees in the home office building. On rainy days the women employees are provided with umbrellas, in case they come to work without them. A branch vacation savings fund is maintained for those employees who desire to save toward their vacation expenses. At the present time there are over 1600 depositors who deposited over $20,000 in 1916. A savings fund for employees was established in 1900. This was intended to serve as a pension fund for those who might become permanently incapacitated. To this fund the company deposits an amount equal to one-half the amount deposited by the employee in the current year. In 1916 there

were 9428 depositors with an amount to their credit, including the company's deposits, of over $3,600,000.

Every effort has been made to maintain a high standard of sanitation in the home office building. Recently an extensive study was made of the ventilation, lighting, water supply, etc., by experts, and their suggestions which have made for the betterment of the working conditions of employees were adopted.

A free dispensary is maintained at the home office, which contains dressing rooms for men and women, examination rooms, and quarters for the treatment of nose and throat conditions, examination of the eyes and minor emergency surgical work. During the year 1916, 25,059 of these conditions were medical and 8438 surgical, while 836 persons' eyes were tested for glasses. Our employees who have been under treatment for tuberculosis are instructed to report to the dispensary at fortnightly intervals for observation and to be weighed. Many of these discharged patients are provided with milk at the dispensary between meals, and during the last year a daily average of 39 persons were given intermediate milk diets.

A further step in the conservation of health was made in 1915 by the establishment at the home office of a dental clinic for employees. It had been found that large numbers suffered from impaired teeth, and it seemed advisable to offer an opportunity to these people to have a careful oral examination and cleansing of the teeth made. The teeth are now examined and cleansed semiannually without charge. The employees are referred to their own dentists for needed fillings, etc., and later return for examination to show that the work has been carefully done. The 1916 report of the dental division shows that since the last examination 3856 fillings and 189 crowns had been made by the employees' dentists as a result of the examinations and recommendations at the home office. Emergency cases are treated in the dental clinic without charge, and only recently the employees have been given the privilege of having their dental work done in the clinic from 4.30 to 6.30 p.m., at prices which are practically cost. During the last year 4220 examinations and cleansings were made, 1316 emergency cases were treated and 2787 x-ray pictures were taken. Five dentists are in attendance throughout the day and many interesting and valuable studies have been made since this clinic was opened in 1915. In the past year a class of 1000 cases showed clearly the benefits of observation and cleaning. They were given three examinations. On the first examination, 28.3 per

cent had mouths classed as unclean. On the second examination, 22.7 per cent fell into this class, and this percentage was reduced to 19.7 at the time of the third examination.

In 1910 the Metropolitan Company began to examine physically all applicants for employment, and in 1914 started a yearly physical examination of all home office and field employees. This yearly physical survey of 19,000 employees is made in order to detect beginning impairments which may be corrected by prompt treatment. The examination is the same in character as is made on application for ordinary life insurance for $1000 or more. It is of interest to know that in the 1914–1915 examinations of 4431 home office employees, the rate of active tuberculosis cases found was 2.3 per thousand. The arrested cases gave a rate of 5 per thousand. In his report the statistician, Dr. Dublin, points to the fact, "that the existence of the company's sanatorium and the active search for cases in the company's dispensary serve to reduce our (tuberculosis) rate on the physical examination."

Aggressive antituberculosis work by the company dates from 1909, when, following the inspiration of the International Tuberculosis Congress of 1908, it was decided to build a sanatorium for the care of its tuberculous employees. At this time the Superintendent of Insurance of New York State decided that an insurance corporation had no right to purchase property for such a purpose. The legality of the matter was then tested and a decision of the Supreme Court rendered, declaring that any corporation had not only the right but the duty to give reasonable care to its employees. This epoch making decision opened the way to the building of the company's sanatorium at Mt. McGregor, the first institution of its kind erected by a corporation for the benefit of its employees. The sanatorium was opened in the fall of 1913 with a capacity of 77 beds. An educational campaign among the employees was immediately undertaken to show them the necessity of early treatment of the disease. With this end in view the company's superintendents from the various parts of the country came to the sanatorium and were instructed in the cardinal symptoms which suggest possible development of tuberculosis, in order that they might apprehend employees in whom the disease was developing and have them examined. The results of this campaign were almost immediate, and many employees had their symptoms of beginning disease detected while they still had the possibility of rapid and permanent recovery.

This continued education of employees, together with the annual

examination of the home office and field forces, has resulted in an increasing percentage of incipient cases admitted to the sanatorium. During the year 1914, 29 per cent of incipient cases were admitted; in 1915, 44 per cent; and in 1916 the percentage had increased to 55. The company is making every effort to have all tuberculosis among its 20,000 employees detected in its early stages. The capacity of the sanatorium has been steadily increased and there are now over 200 cases of tuberculosis being cared for. In addition to caring for tuberculous employees, it was decided to build a rest house in which employees suffering from other diseases and conditions which could be benefited by country life, dieting, regulated exercise, rest, etc., could be cared for, and this building with a capacity of 80 patients has recently been completed and is now occupied, giving a total sanatorium capacity of 309. Primarily of course the object of building the sanatorium was to care for those afflicted with tuberculosis. Secondarily it was hoped that the building of such an institution by a corporation might serve as an incentive to other corporations to undertake work of this kind. It was also thought that the sanatorium might serve as a model after which other sanatoria could pattern any features that seemed to them desirable. It may be of interest to know that the care of the patient is entirely free. He is given transportation from his home to the sanatorium, is cared for during his convalescence, and returned to his home when he has recovered. In some instances it has been found advisable to send the patient after recovery to a more favorable climate in another state or district than his own, but in all cases a position awaits recovery.

Tuberculosis is a disease which largely affects working people, and usually it happens that sufficient sums have not been laid by to provide for the care of the dependent members of the family while the wage earner recovers his health. Consequently many worries and anxieties retard and sometimes prevent recovery. The Metropolitan Company, in a very large measure, has overcome this economic defect by providing a form of group life and disability insurance, which went into effect in 1914. This insurance makes provision against sickness and accident, the company paying one-half of the premium. It provides for the payment of two-thirds salary during the first twenty-six weeks of illness, beginning with the eighth day's sickness, and one-half the original benefit from the twenty-seventh week to the expiration of the fifth year of sickness. If incapacity unfortunately continues beyond this period, one-fourth the original benefit is paid until the employee reaches

the age of sixty-five. The benefits of this plan are too obvious to require elucidation.

Due to the fact that nearly all sanatorium ex-patients remain in the service of the company, unusual opportunities are afforded to observe and record their physical condition from time to time after discharge. At the annual examination of employees the condition of ex-patients is noted with considerable particularity and it is hoped that this follow-up record, depending as it does upon the yearly physical examination, may contribute somewhat to our knowledge of the results of sanatorium treatment.

A further object in establishing a sanatorium was that whatever knowledge of the disease and its prevention was acquired might be transmitted to the large body of policy holders. It has been the hope of the company that those employees who were treated in the sanatorium might upon the resumption of their work become veritable health missionaries, that they might through their experiences have learned the advantages of fresh air and proper living, and that these facts might by them be transmitted to those with whom they come in contact. An effort is made to give to the patient much practical knowledge concerning the prevention and treatment of tuberculosis and the application of sanitary measures which will aid in improving the health of communities. That this educational campaign is beginning to show returns, although it has been carried on only a short time, is manifested by the reports for 1916, which show that over 100 known cases of tuberculosis among policy holders were persuaded by sanatorium ex-patients to enter sanatoria for treatment of their disease. From these various ex-patients scattered over the country, the sanatorium constantly receives letters concerning the treatment of various health problems about which they are perplexed in their work among policy holders. There is reason to believe that with this beginning there should finally become a body of workers whose influence among the policy holders of the company in the prevention of disease will be indeed appreciable.

As indicated earlier, the reduction in mortality throughout the country prior to the twentieth century came to a large extent independently of any intentional activities of insurance companies, notwithstanding the fact that they were to benefit materially from any improvement in the health of the public. The recent history of life insurance in America shows a decided awakening to the possibilities of further conservation of human life and it seems likely that this will now become a very important phase of work with all large companies. To indicate

the modern trend of thought I will quote from a recent address of Vice President Fiske of the Metropolitan Life Insurance Company, in which he says:

> The latest development of life insurance in this country is interesting, and, to those who know the history of the business, really amazing. It is distinctively American, for it is seen in no other country. It is doubtless the outgrowth of the sentiment which of late years is pervading society throughout the world, and in this country especially has involved industrial and commercial business; the sentiment that there is a responsibility resting upon the prosperous to help the less fortunate; that there is a duty to the community to better conditions and uplift the mass. As life insurance is based upon mortality, it is a logical working out of this sentiment for the insurance companies to do something to lower the death rate, to conserve health and lengthen human life. It is the same sentiment which leads manufacturers to improve conditions of labor and domestic life of wage earners and to promote thrift.

Frequent opportunity has been given to the company to aid its policy holders in times of emergencies. Material assistance was given at the time of the San Francisco earthquake and fire. A special nurse for policy holders was provided at the time of the typhoid epidemic in Torrington, Connecticut, in 1911. Milk was daily supplied to children of the refugees during the Memphis flood of 1912. Financial assistance was rendered for the purchase of food and clothing during the Ohio Valley flood of 1914. Frequently in times of epidemics the company has had occasion to issue pamphlets which were widely distributed to assist health officers in bringing to the notice of citizens the needful things to be done. In the year 1916 there was an increase of 70 per cent in the numbers of cities in which such publications were used, and in many instances these pamphlets were the only literature available in popular form. During the infantile paralysis epidemic of last summer about 650,000 copies of special circulars were distributed in several hundred communities and were used freely by the health departments.

During last year alone assistance was given in over 330 clean-up and fly campaigns in the cities of the United States and Canada. Nearly 350,000 special circulars were distributed in Chicago, St. Louis, Boston and Hoboken, and over 1,000,000 copies of other welfare literature in other places in connection with these campaigns.

In 1909 there was established by the company a nursing service which offered to industrial policy holders, free of charge, the services of a nurse in times of acute sickness and at the time of maternity. This service

has been rapidly extended and now reaches about 9,000,000 policy holders in the United States and Canada. In about 2,000 cities and towns over 1,000,000 visits are made annually. It can be readily appreciated that a corps of trained nurses who make visits to 9,000,000 people a year are likely to exert a powerful influence in the education of these people in matters pertaining to their health. They also have and exercise the opportunity to assist in the instruction and isolation of tuberculous patients found in homes. Their greatest opportunity in the antituberculosis work, however, comes from their ability to intelligently instruct people in the dangers of infection of children who are exposed in the home and the proper protection of susceptible individuals.

To appreciate partially the opportunities for life extension work by life insurance companies, one has only to consider that the Metropolitan Company alone has approximately 12,000,000 policy holders in this country and Canada, the majority of whom carry industrial insurance, and whose premiums are collected weekly by an agent of the company. Through this direct communication there are many opportunities throughout the year for the transmission of messages from the company to the insured. Pamphlets dealing with health matters in general or those of a specific nature are often sent to the policy holders, and are delivered by the hand of an agent within a few days after leaving the home office. This furnishes an opportunity to translate to millions of individuals the best thought of the day with respect to the modern point of view in preventive medicine and life prolongation. These pamphlets are prepared in popular form by experts who are familiar with the subject treated. They are printed by thousands and often millions, for distribution. A few of those which have been sent out from time to time during the past few years and the numbers which have been printed and distributed will serve to illustrate the extent to which this campaign has been carried on:

Fake Consumption Cures	550,000
A War upon Consumption	6,000,000
The Child (English)	2,000,000
The Child (Foreign)	750,000
Teeth, Tonsils and Adenoids	3,000,000
Dirty and Clean Milk	5,000,000
Paper Drinking Cups	33,000,000

In addition, a quarterly magazine, "The Metropolitan," is printed and distributed to policy holders, in issues of over 4,500,000 copies. During the past year health officers throughout the country were

invited to present in its columns any health message which they desired to bring to the attention of the policy holders of their communities. This opportunity was largely availed of throughout the year.

In an attempt to determine the ways in which the company's further activities might best be directed, a series of health surveys has been instituted to ascertain the percentage of sickness in certain communities. The first survey was made in Rochester, New York, in 1915. Since then surveys have been made in Trenton, New Jersey, Boston, Massachusetts, and the entire state of North Carolina. These inventories of sickness which were made by the company's agents, are considered authentic, and are being used by health officers and others to recall to residents of communities conditions which require correction.

The company has for years attempted to assist communities in various parts of the country that are desirous of establishing tuberculosis sanatoria. Where the question has been submitted to a vote of the people, the policy holders have been reached with special circulars, emphasizing the value of a sanatorium in the community and urging their support. This action has been taken frequently at the request of states, municipalities, and counties. During 1916 three counties in New York State were assisted successfully to secure sanatoria. Assistance was likewise given in the city of Cincinnati to secure additional facilities to the present sanatorium.

I shall speak very briefly of the gift of $100,000 last year by the Metropolitan Life Insurance Company, for making an effort in a community to control tuberculosis. Framingham, Massachusetts, has been selected for this demonstration, and it may be of interest to recall one or two of its objects, as published in a recent number of the bulletin of the National Association:

> This educational campaign will be aimed at the detection of early cases of tuberculosis, and will urge the prevention of infection and the creation of healthful conditions. . . . Incidentally, the educational campaign will also urge thorough annual medical examinations for everyone. . . . This thorough medical examination ought to result in the detection not only of early and easily curable cases of tuberculosis, but in many other things that can be treated successfully only when discovered early, such as cancer, Bright's disease, etc.
>
> Home care, with adequate nursing and medical facilities for tuberculosis cases will be urged. Hospital care, in state or county institutions, will be recommended and provided for in some way when necessary.

Under the heading, "Results expected and hoped for," the committee announces its purpose as follows:

> The discovery and adequate care of all cases of tuberculosis, the reduction of sickness and deaths to a minimum. . . . . The demonstration of the belief that disease prevention for any town is cheaper than disease, both to the town and to the sick person. . . . The making of Framingham the world's healthiest spot and hygienic Utopia. . . . The demonstration of a worthy program for the conquest of tuberculosis and for the improvement of health.

This, in brief, is a review of the health conservation work of one of the large insurance companies. The efforts to prolong lives which have been made are of comparatively recent origin and further work is now being undertaken. It is not to be expected that striking reductions in mortality should have been brought about in this short time. There is, however, satisfactory evidence that the health and sanitary conditions of many communities have been improved through the activities of life insurance companies. Moreover, the mortality experience of the Metropolitan Company in certain diseases as typhoid fever, diseases and conditions of the puerperal state and infectious diseases, shows a greater reduction during the years 1911–1915 than is shown in the registration area for the same period. These particular diseases are covered by the company's nursing service, and while it is difficult to estimate the value of any health conservation agent from a close perspective, there is reason to believe that the efforts of the company have had an influence on the mortality reduction since their experience has shown greater reduction than that of the population in the registration area. The two outstanding and encouraging features of this work as it relates to the antituberculosis movement are, first, the desire of insurance companies to aid in every possible way to save and prolong the lives of their policy holders, and second, the manifold opportunities which are theirs for education in health matters of a large portion of our citizenry. Life insurance is carried by about one-fourth of the people of this country and Canada. With a vigorous prosecution of the educational campaign through all of the channels available to life insurance companies it is not beyond the bounds of reason to expect a further material reduction in mortality and mortality rates among their policy holders, and the influence of any such campaign is never limited to those whom it directly serves, but spreads throughout communities in which it is carried on.

MEDICAL NOTES, ABSTRACTS AND REVIEWS

It will be the eventual purpose of the REVIEW thoroughly to canvass all literature on tuberculosis as it appears in other medical periodicals and to present it in abstract form. Authors are requested to send abstracts or reprints of their papers to the Abstract Editor, Dr. George Mannheimer, 41 West 51st Street, New York, N. Y. In the present number many of the abstracts have been taken from other medical publications, such as the Journal of the American Medical Association, the Medical Record, the New York Medical Journal, etc., to whom acknowledgment is due.

Pott's Disease.—Jacobs has been impressed in his experience with the frequent occurrence of compression paralysis and its severity and mortality in Pott's disease of adults. In seventy-five patients in Cook County Hospital between the ages of nineteen and sixty-two years, paraplegia occurred in twenty-four with sixteen deaths, and in the remaining eight cases the termination was unknown. Surgical treatment had been used in thirteen. Necropsies were made in seven cases, of which five had compression paralysis. There are two factors to be considered in compression of the cord in tuberculous disease: First, pressure from tuberculous granulation tissue, occurring mostly in children, and second, pressure from intraspinal abscess, usually seen in adults, which tends to produce severe injury to the cord. In roentgenographic examination of cases of tuberculous spine disease available for study, intraspinal abscesses were observed in eighteen, fifteen of whom had clinical symptoms of the abscess. In children, spinal abscess is only of occasional occurrence, as shown by the roentgenogram. Jacobs doubts the value of recumbency in the treatment. It does good, in cases with granulation tissue instead of with an abscess. In the abscess cases treatment has been without favorable effect, and several of these are reported. While at first the pressure may not cause any appreciable damage to the cord, sooner or later this occurs and it follows that the paraplegia will be complete and permanent as a rule, and death may be anticipated, generally from the pulmonary disease. No reliance can be placed on operative procedures. Where laminectomy has afforded relief by the accidental evacuation of the abscess, it is a serious operation and immediate mortality is large.—*Compression Paralysis of Pott's Disease in Adults. C. M. Jacobs, J. Am. M. Ass., February 17, 1917, LXVIII, No. 7.*

Spinal Tuberculosis.—Report of forty cases of spinal tuberculosis treated by internal splintage. Two methods of operation have been used, the osteoplastic, known as Hibbs', and the bone-transplant, known as Albee's. Nine of the forty patients were adults, and thirty-one were children. The diagnosis of spinal tuberculosis and its location and extent were clearly made out by the Roentgen ray and by clinical tests for tuberculosis, and wherever possible by guinea pig inoculation. The Hibbs operation was used in ten cases and the Albee in thirty. The cases are divided into three groups: Group 1: Patients operated on in the early stages of Pott's disease with little or no evidence of deformity, and no complications. Fifteen of the forty were of this group. Group 2: Patients operated on who presented well marked deformity with persistence of more or less acute symptoms but no complications. There were nine of these. Eight have made recovery and are in fairly robust health. One has shown a return of acute symptoms after three years and has signs of a developing pressure paralysis. Group 3: Patients operated on in the presence of complications to their more or less acute tuberculosis of the spine. These different conditions are noticed more in detail. The authors have discovered what seems to them a valuable method of holding these cases fixed immediately after operation. It is their custom to reverse the Whitman frame so that it lies concave on the bed and place the child face down on this frame, securely binding it as one would in the reverse position. In this way there is no pressure on the operative wound and hyperextension is more or less perfectly kept up. They believe it highly advisable and sometimes absolutely necessary to continue support for at least one year after operation. They are led to this belief by the character of bone regeneration which must

take place before the spinal column becomes securely ankylosed, and they feel that the too early removal of supports may lead to a return of symptoms and increase in deformity. They have had good results with both operations, as their experience has been good with each. The Albee operation is more simply done and on that account more advisable in most cases. Experience with adults and children has been about the same. They feel, however, that the good results obtained are much more conclusive in the case of adults, who respond very slowly to conservative measures. A summary of their results is given as follows: "Forty patients were operated on. Two deaths were due to tuberculous meningitis. There were three infections at the time of operation without serious consequences. Fifteen patients completely recovered without deformity or complication, and at the present time are far enough along since their operation to be called absolutely well. Eight patients have deformity, but with the disease arrested and no active symptoms. Of the sixteen patients who had complications, three with paraplegia have completely recovered, and two have died. Of those with pulmonary tuberculosis (four patients) there is evidence of activity of disease at present, but the disease of the spine is not causing symptoms. Of the patients with tuberculosis of other joints (two) these are still under treatment, but are making slower recoveries. Of the patients with psoas abscess all five have recovered and the abscesses have ceased to discharge. The total of this group would be four cases of pulmonary tuberculosis, and two of tuberculosis of other joints, making six still under observation, leaving ten in which the disease has been arrested. We are led to believe from this experience with forty cases that an operation for ankylosing the spine should be performed in every case of Pott's disease as early as a diagnosis can be accurately made, and that the presence of complications should not influence the surgeon in delaying the operative procedure, unless the complications are of too grave a nature. We do not feel in a position to discuss the relative merits of the Albee and the Hibbs operations. We have had equally good results with each procedure. We feel, however, that the Albee operation is more simply done and that on this account it is advisable in the majority of instances. Our experience with adults and children has been about the same. We feel, however, that the good results obtained are much more conclusive in the case of adults, who respond very slowly to conservative measures."—*Spinal Tuberculosis, N. Allison and H. H. Hagan, J. Am. M. Ass., February 10, 1917, LXVIII, No. 6.*

Hypertrophic Osteoarthropathy.—The 32 patients reported on were in the second or third stage of the disease. Following the classification of Locke, they were divided into 3 groups: 1) 5 patients presenting simple, well-defined clubbing of the fingers without bone changes, 2) seventeen patients showing clubbing of the fingers with bone-changes in the phalanges, 3) ten patients with clubbed fingers and changes in the long bones. Roentgen examinations were made of the hands and feet, all of the long bones, the bones of the pelvis, and in some instances the shoulder girdle and cranial bones. A comparison of the clinical course with these findings brought out the following facts: 1) The degree of clubbing corresponds only in a general way to the radiographic findings. 2) Bone changes occur more commonly than is ordinarily supposed in the so called simple clubbed fingers. 3) Pronounced changes in the long bones take place without any clinical sign or symptom being present. 4) Systematic Roentgen-ray examinations reveal such damage. 5) The type of bone change in the various groups is the same, the difference being rather in the degree. 6) Hypertrophic osteoarthropathy is present more frequently in pulmonary tuberculosis than the usual clinical examination would permit us to believe.—*The Relation of Hypertrophic Osteoarthropathy to Pulmonary Tuberculosis. L. Kessel, Arch. Int. Med., February 1917, XIX, No. 2, 239.*

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* "The Choice of Tuberculins," by Benjamin White, Otisville, N. Y., Department of Health, City of New York. Read at the annual meeting of the Medical Society of the State of New York, at Saratoga Springs, May 18, 1916.

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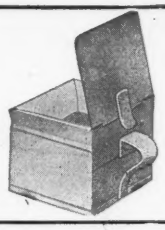

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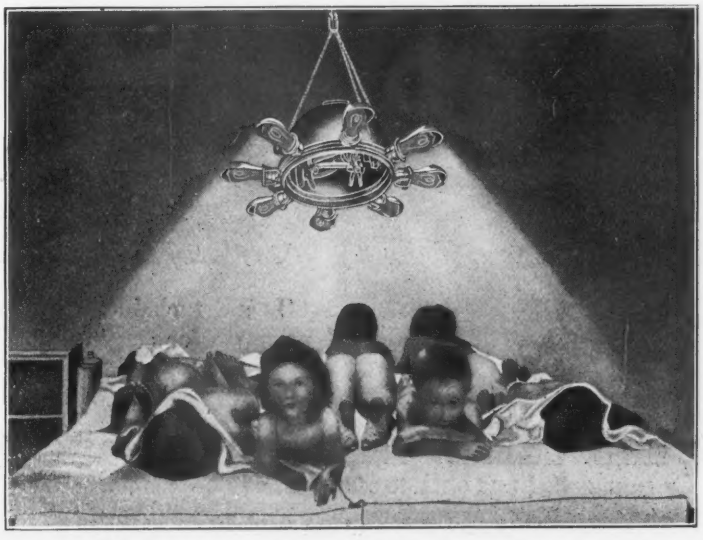

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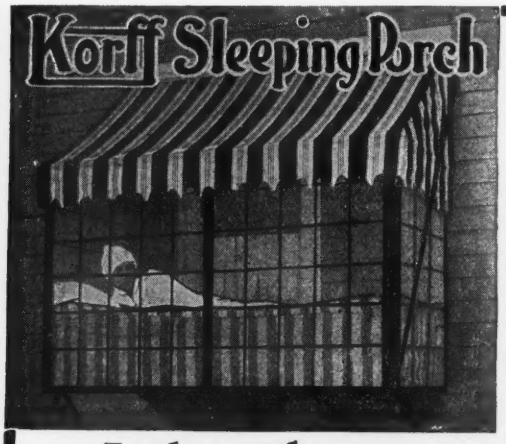

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Each patient has *private apartment and* sleeping porch with *private baths.*

Cragmor is located in the shelter of Austin Bluffs 2½ miles from Colorado Springs. *Its site,* especially chosen, *affords a wonderful view of Pikes Peak* and the Rampart Range of the Rockies.

The climate and altitude of this region have made it *one of the best known resorts* for the treatment of Tuberculosis. The constant *sunny days of Fall and Winter make "taking the cure" pleasant and comfortable.*

MEDICAL DIRECTORS

ALEXIUS M. FORSTER, M.D. - - - - - *Physician in Chief*
GERALD B. WEBB M.D. and GEORGE BURTON GILBERT, M.D. - *Consultants*
FRANK M. HOUCK, M.D. - - - - - - *Superintendent*

For full particulars address the Physician in Chief